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December 1995

Ship Navigation Simulation Study, Southern Branch of the Elizabeth River, Gilmerton and Interstate 64 Bridges, Norfolk, Virginia

by Dennis W. Webb

Prepared for U.S. Army Engineer District, Norfolk

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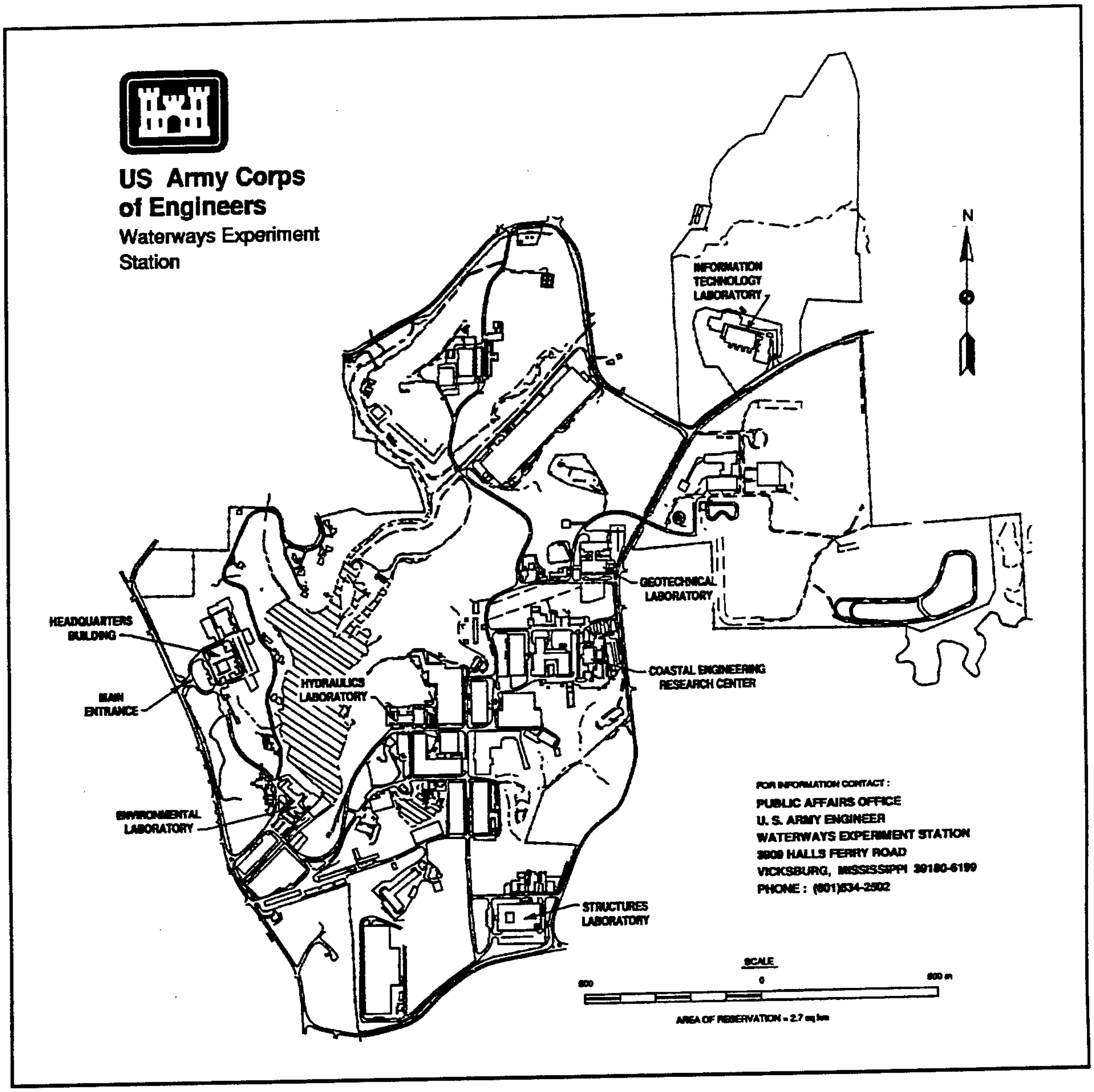

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Preface

This investigation was performed by the Hydraulics Laboratory (HL) of the U.S. Army Engineer Waterways Experiment Station (WES) for the U.S. Army Engineer District, Norfolk (NAO). The study was conducted with the WES research ship simulator. NAO provided survey data of the prototype area. Current modeling was conducted by the Estuaries Branch, Waterways and Estuaries Division, HL. The study was conducted during the period February 1994-December 1994.

The investigation was conducted by Mr. Dennis W. Webb, Simulation and Modeling Group, Navigation Division, HL, under the general supervision of Messrs. Richard A. Sager, Acting Director, HL; Robert F. Athow, Acting Assistant Director, HL; and Dr. Larry L. Daggett, Chief, Navigation Division. Ms. Peggy Van Norman, Simulation and Modeling Group, also participated in the study. Messrs. Ben Brown and John Cartwright, Estuaries Branch, prepared Appendix A.

Acknowledgment is made to Mr. Richard Klien, Engineering Division, and Mr. Mark Mansfield, Planning Division, NAO, for their cooperation and assistance at various times throughout the investigation. Special thanks should go to McAllister Brothers Towing and Allied Towing, Newport News, VA, for access to vessels and for furnishing professional pilots to conduct ship simulator tests on the WES ship simulator. Special thanks also go to the independent pilots who participated in the testing program. Messrs. Ben Brown and John Cartwright, Estuaries Branch, performed current modeling, and Thad Pratt, Prototype and Field Studies Group, collected field data.

During the preparation and publication of this report, Commander was COL Bruce K. Howard, EN. Director of WES was Dr. Robert W. Whalin.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
degrees (angle)	0.01745329	radians
feet	0.3048	meters
horsepower (550 foot-pounds (force) per second)	745.6999	watts
knots (international)	0.514444	meters per second
miles (U.S. statute)	1.609344	kilometers

1 Introduction

The Southern Branch of the Elizabeth River flows through Norfolk, Portsmouth, and Chesapeake, VA (Figure 1). The area of this study is located entirely within the city of Chesapeake. In 1989, the U.S. Army Engineer Waterways Experiment Station (WES) conducted a navigation study for the U.S. Army Engineer District, Norfolk, to evaluate a proposed navigation channel improvement project for the entire Southern Branch (Webb and Daggett, in preparation). This study was conducted in Vicksburg, MS, using the WES ship/tow simulator. Recommendations for the reaches between the Norfolk and Western Railway bridge (NWRB) and the Gilmerton Bridges (Figure 2) included deepening the authorized channel from 35 to 40 ft,[1] widening several of the bends, and constructing a turning basin opposite Milldam Creek, near the Elizabeth River Terminals (ERT). To date, none of the recommendations from this study have been constructed.

In 1992 the local sponsor asked that the 35- to 40-ft deepening project be revived and extended south to the Newton Creek Turning Basin. Other new developments in the area include proposals for the construction of two new docks on either side of the river (Figure 3), the possible replacement of the Gilmerton Bridges (both the highway and railroad bridges) and the Interstate Highway 64 (I-64) bridge, and the impact of the 1989 Milldam Creek Turning Basin on wetlands in the Gilmerton Bridge area (Figure 4). The Gilmerton Bridges are candidates for replacement under the Truman-Hobbs Act of 1940, while the I-64 bridge is not.

The District requested that WES extend the simulation model databases to the turning basin south of the I-64 bridge and conduct additional testing in the area. The additional testing is required to evaluate these proposed changes to the Southern Branch of the Elizabeth River.

Existing Conditions and Navigation Problems

The existing 125-ft-span Gilmerton Bridges are located just south of an approximately 90-degree bend in the river. Therefore, inbound (southbound)

[1] A table of factors for converting non-SI units of measurements to SI units is found on page viii.

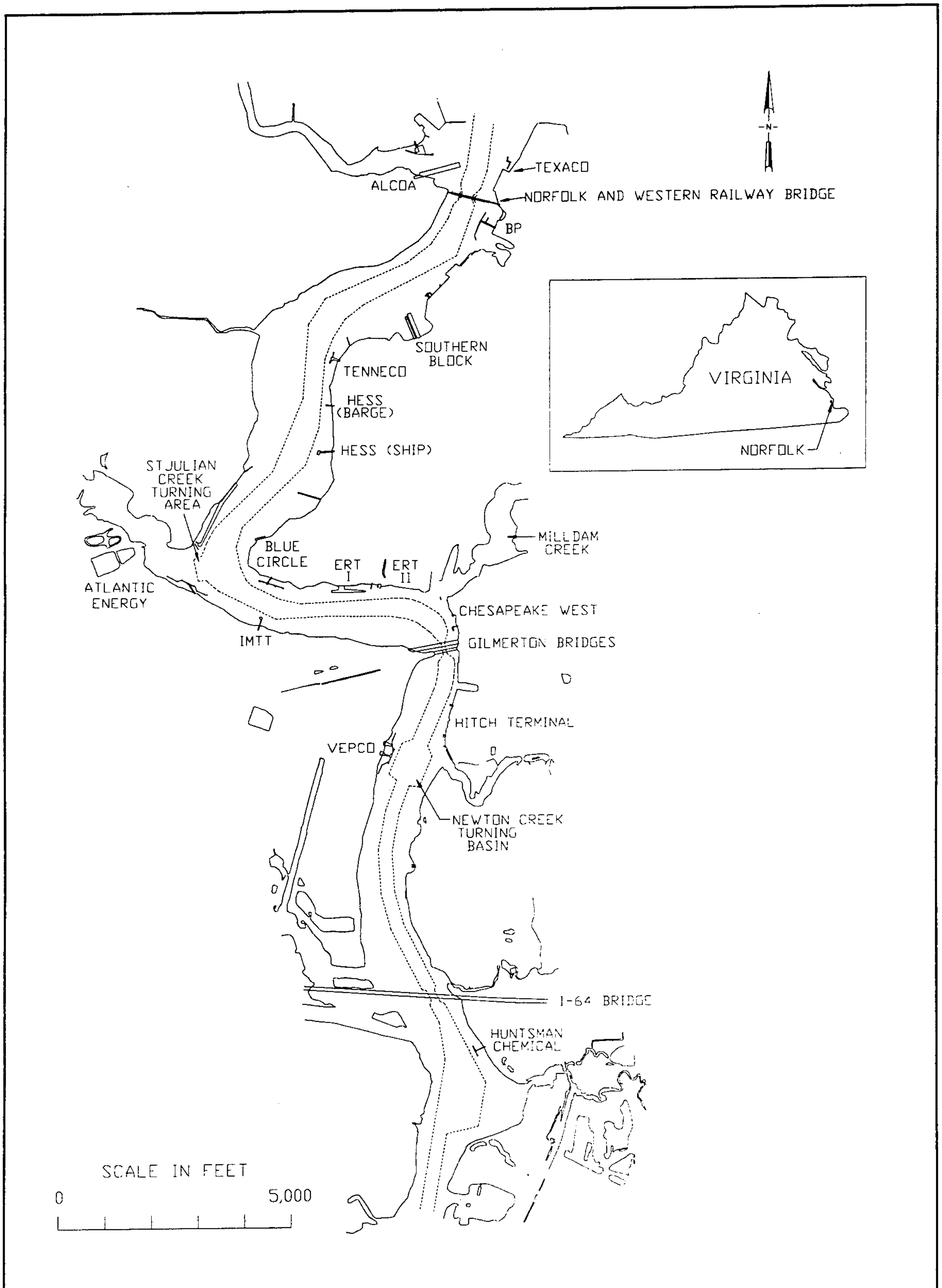


Figure 1. Location and area map

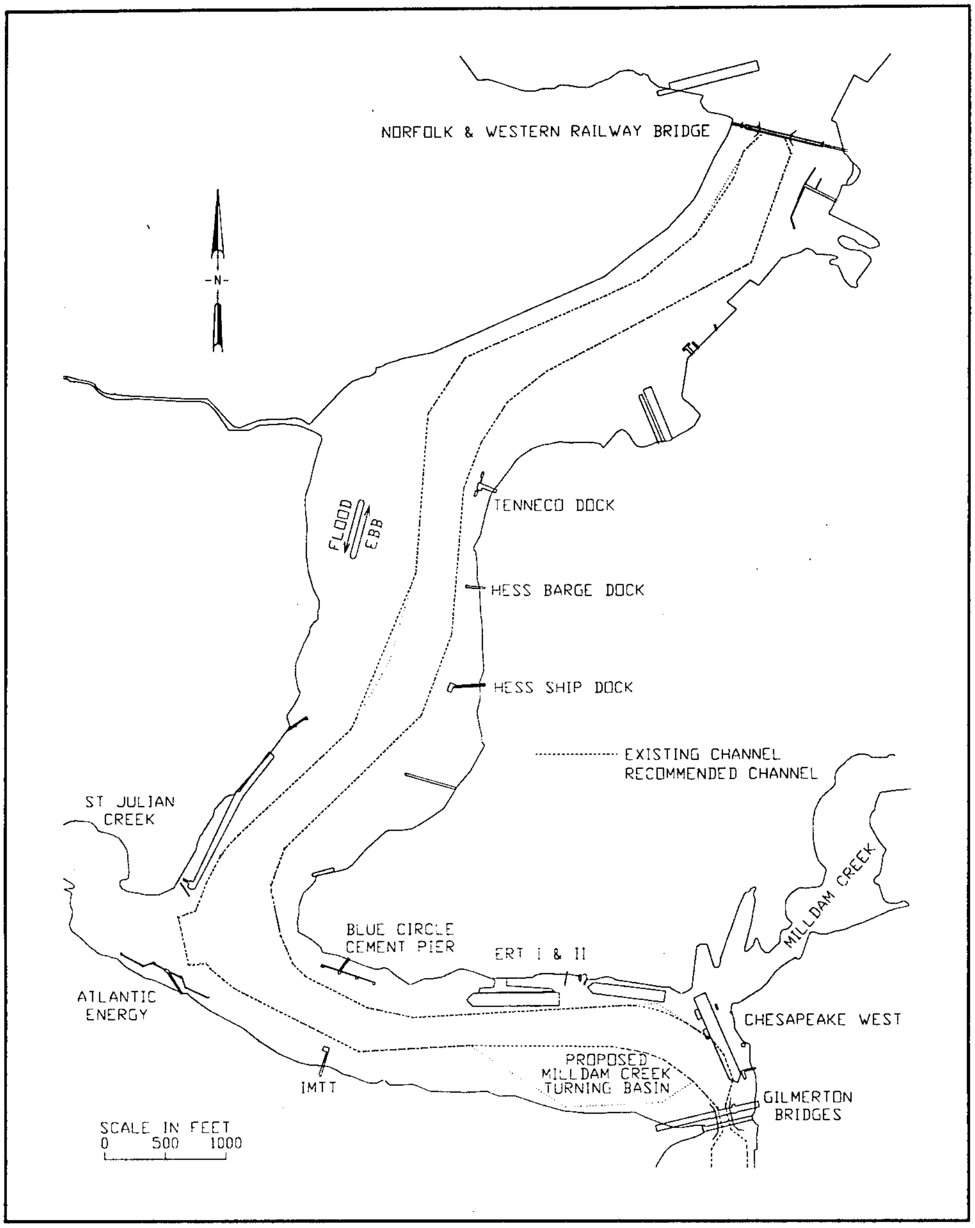


Figure 2. Recommended channel, 1989 study

vessels have very little room to line up with the bridges' fender system. Outbound ships have to turn to port immediately after passing through the bridge span or risk an allision (i.e., a collision with a stationary object) with the ERT II facility immediately north of the bridges. Vessels are often docked on the eastern side of the river, upstream and downstream of the bridges. This further reduces the area available for the mariner to maneuver his vessel.

The Chesapeake West Terminal (Figure 5), a scrap metal facility, is located just north of the bridges. There is often a ship (with loading barges alongside) docked at this facility while being loaded. The ship and barges encroach upon the channel, further constricting the reach north of the Gilmerton Bridges.

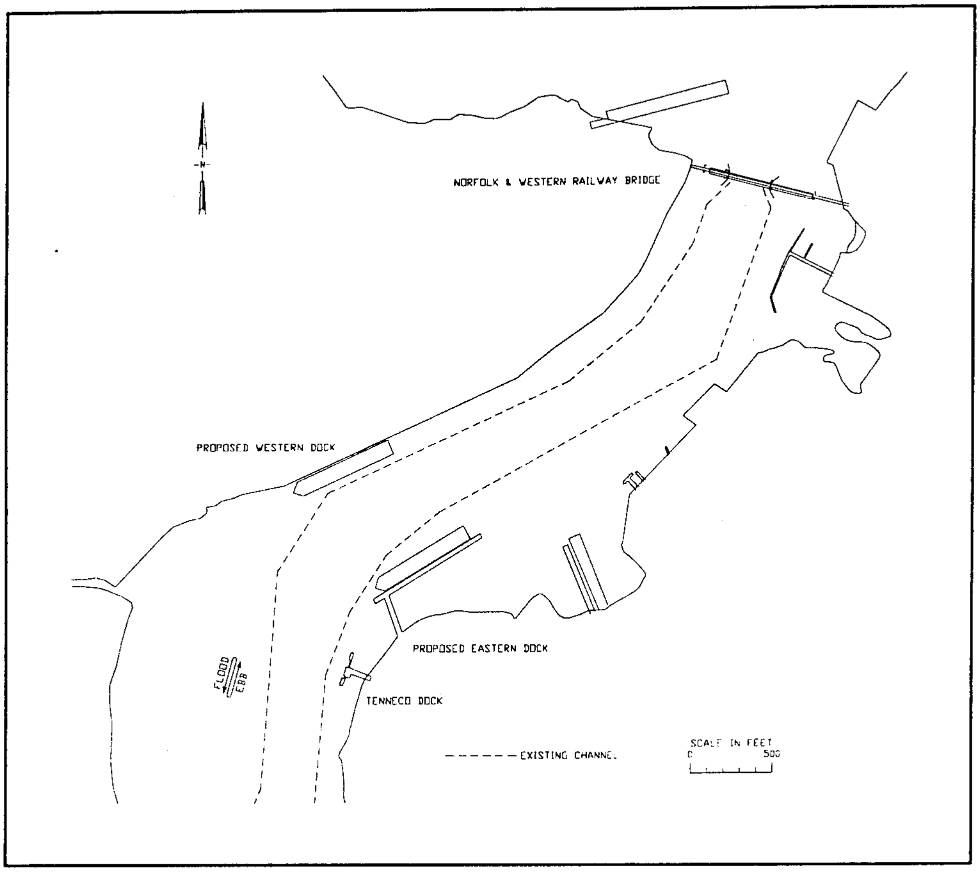


Figure 3. Proposed dock locations

Vessels passing under the bridges include ships and barge traffic. The focus of this investigation was on the primary users, ships and oceangoing, integrated tug/barge units. At the present, ship traffic terminates at Newton Creek Turning Basin. The integrated tug/barges travel south of the I-64 bridge to call at the Huntsman Chemical Dock. Both ships and barges are loaded for the inbound transit. Outbound barges are empty and outbound ships are light-loaded or in ballast. The outbound condition is regarded as the most difficult to navigate because the increased freeboard is subjected to wind. Winds in the area are predominantly from the northeast and northwest. The outbound runs pose an additional problem for the integrated tug/barge units because empty barges extend well past the waterline and block the view from the tug's pilothouse.

The I-64 bridge crosses a straight reach of the channel, but the bridge supports are not aligned with the channel. The bridge itself is at an angle of 59 degrees, not perpendicular, to the channel alignment. In addition, the navigation opening is not in the center of the river; therefore, tug captains experience difficulties lining up their vessels with the center of the bridge span. There are no ranges marking the center line of the channel in this area.

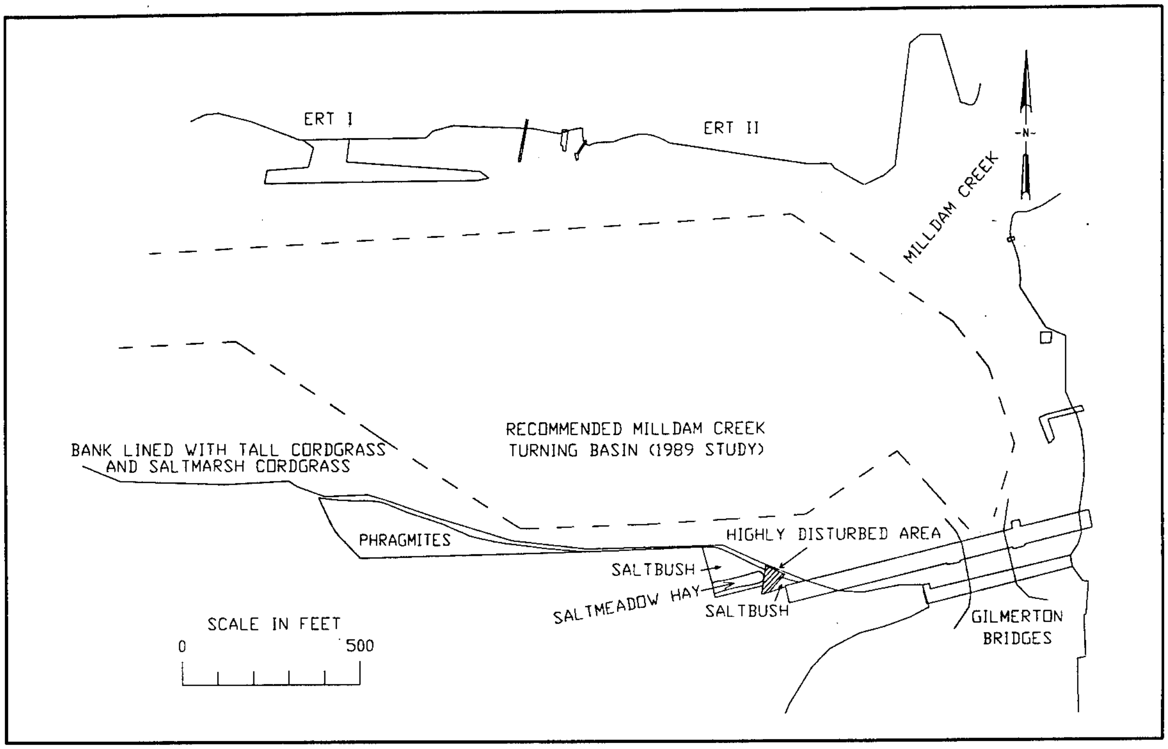


Figure 4. Location and type of wetlands

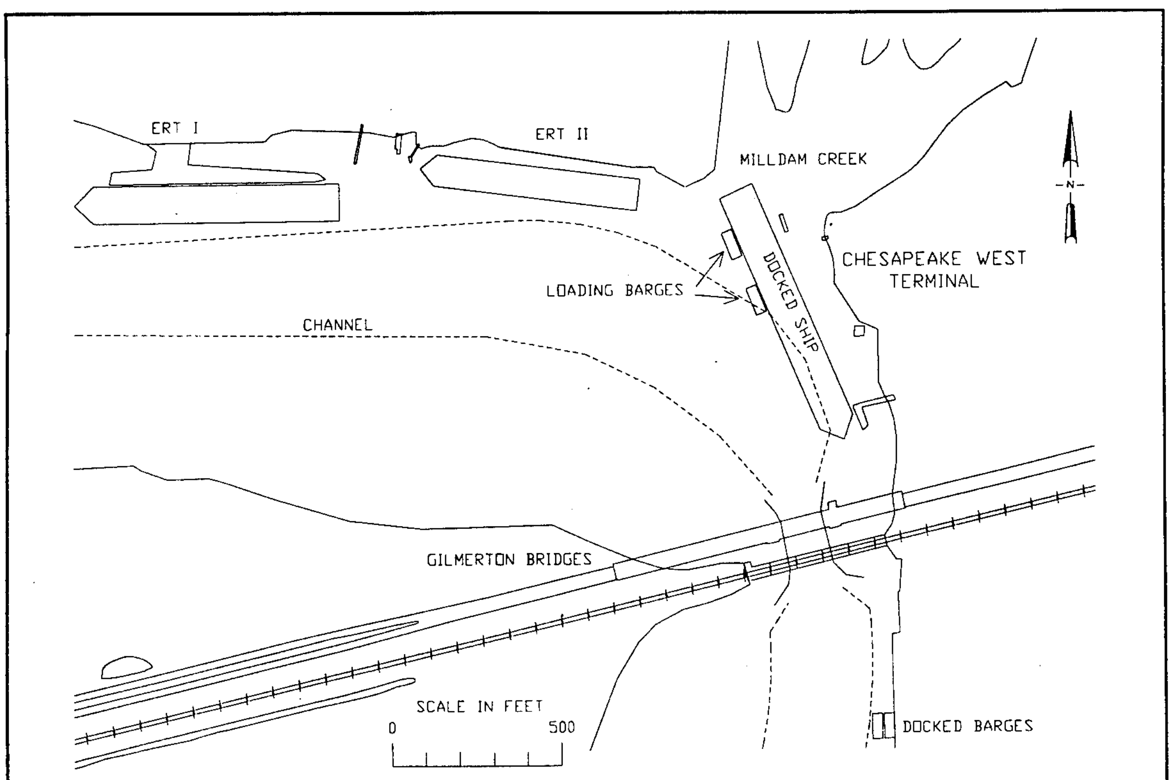


Figure 5. Vessels docked near Gilmerton Bridges

Proposed Channel Improvements

The Norfolk District has proposed the evaluation of span widths of 135, 145, and 150 ft for both the Gilmerton and I-64 Bridges. Any widening of the spans on the Gilmerton Bridges would be only on the western side of the bridges. The effectiveness of any widening on the eastern side is limited because vessels dock on that side. For the purposes of this study, the widening of the I-64 bridge was assumed to be from the channel center line. It was decided that the three bridge span widths would be pretested with the WES ship/tow simulator. One span width for the final testing program was chosen based on these preliminary design tests.

Any modifications to the design of the proposed Milldam Creek Turning Basin could have an effect on the inbound approach to the Gilmerton Bridges. Therefore, it was decided that any such modifications would be evaluated during the preliminary design study.

Purpose and Scope of Investigation

The navigation study was conducted using the WES Hydraulic Laboratory's ship/tow simulator facility. The objectives of the study were to

a. Evaluate the effects of extending the 40-ft channel depth improvement to the Newton Creek Turning Basin.

b. Evaluate the 40-ft channel deepening plan with widening as recommended by the 1989 study, and evaluate the effects of two proposed dock facilities on this channel plan. Each of these facilities will require removal of a channel marker.

c. Evaluate modifications to the Milldam Creek Turning Basin, with consideration to reducing impacts on wetlands and real estate requirements.

d. Evaluate navigation conditions for both ship and barge traffic through the existing 125-ft-wide Gilmerton Bridges and recommend a bridge span width for future construction.

e. Evaluate navigation conditions for barge traffic only through the existing 125-ft-wide I-64 bridge and recommend a bridge span width for future construction.

Description of WES Ship/Tow Simulator

The WES ship/tow simulator is a "real-time" marine simulator that can function as either a deep-draft or a shallow-draft simulator. "Real-time" means that the movements on the simulator require the same amount of time as they do in real life. Simulation of the Elizabeth River, Southern Branch, involved having experienced mariners from the project area navigate a simulated vessel through the simulation models of the waterway.

Visual cues given to the mariner during a test run are an animated "out-the-window" view of the project area; radar displays; and a precision navigation display, which includes vessel speed (both absolute and relative to the water), lateral velocities, heading, rudder angle, engine speed, wind, and a rate-of-turn indicator. A schematic diagram of the WES ship/tow simulator is shown in Figure 6.

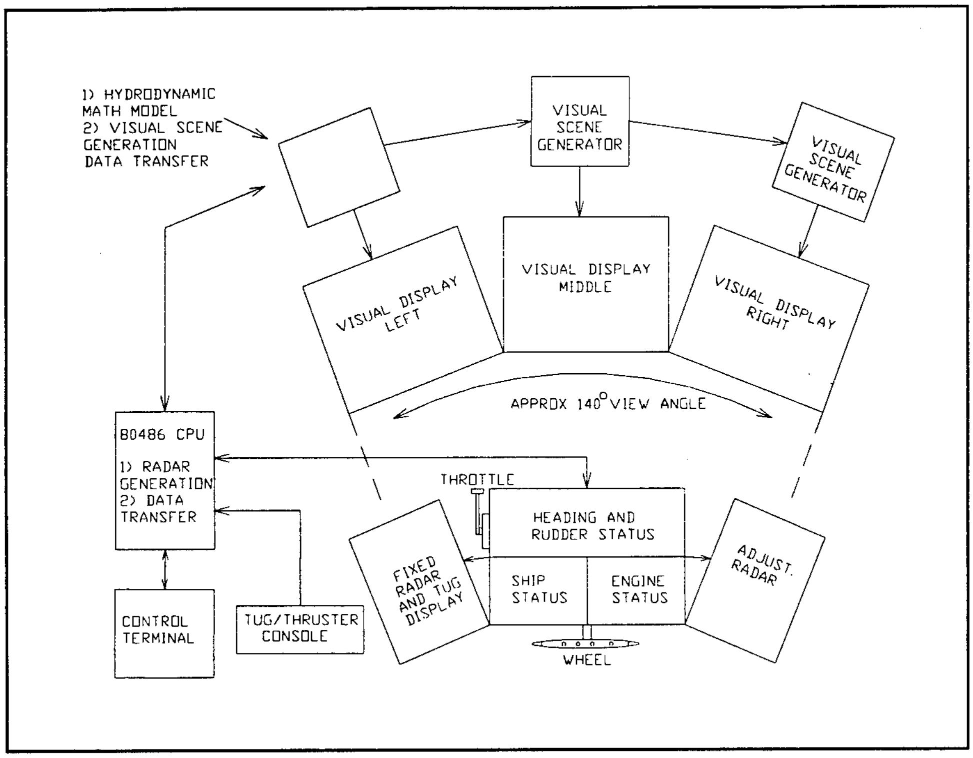


Figure 6. Schematic diagram of WES ship/tow simulator

Mariners operate the simulator through engine, rudder, or tug/thruster commands. The engine and rudder commands are input to the hydrodynamic program at the ship's console by either the mariner or a helmsman. Tug or thruster commands are input by an operator stationed at the tug console. The hydrodynamic program calculates the resultant vessel movement based on these inputs and environmental conditions. The ship's motion is then shown on the visual and radar displays. If necessary, the mariner responds to this movement by issuing additional commands. This interaction of the mariner and the simulation process is known as "man-in-the-loop."

The visual scene is generated in three dimensions: north-south, east-west, and vertical elevation. As the ship progresses through the channel, the three-dimensional picture is constantly transformed into a two-dimensional perspective graphic image representing the relative size of the objects in the scene as a function of the vessel's position and orientation and the perspective from the ship's bridge. The graphics hardware used for the Elizabeth River, Southern Branch, project was a stand-alone computer connected with the main computer to obtain information for updating the viewing position and orientation. This information includes parameters such as vessel heading, rate of turn, forward and lateral velocity, and position. Also, the viewing angle as set by the pilot is passed to the graphics computer for the look-around feature on the simulator console, which encompasses a 140-degree field of view. The pilot's position on the bridge can also be changed from the center of the bridge to any position wing to wing to simulate the pilot walking across the bridge to obtain a better view, e.g., along the edge of the ship from the bridge wing.

Two radar displays are provided for the mariner's use during a simulator run. The radar image is a continuously updated plan view of the vessel's position relative to the surrounding area. The variable scaled radar display provides three different ranges to enable the pilot to choose the scale needed. Ranges of 0.5 mile, 0.75 mile, and 1.5 miles were programmed for the simulation of the Southern Branch of the Elizabeth River. A second radar screen with a fixed 0.25-mile range is also provided to display assisting tug forces. The tug force appears on the radar screen as a vector either pushing or pulling the simulated vessel. The magnitude of the vector is scaled to represent the tug force being applied.

2 Data Development

In order to simulate the study area, it was necessary to develop information relative to five types of input data:

a. The channel database contains dimensions for the existing channel and the proposed channel modifications. It includes the channel cross sections, bank slope angle, overbank depth, initial conditions, and autopilot track-line and speed definition.

b. The visual scene database is composed of three-dimensional images of principal features of the simulated area, including the aids to navigation, docks, and buildings.

c. The radar database contains the features for the plan view of the study area.

d. The current pattern data in the channel include the magnitude and direction of the current and the water depth for each cross section defined in the channel database.

e. The ship data file contains characteristics and hydrodynamic coefficients for the test vessels.

Channel

Channel cross sections are used to define the ship simulator channel database. The information used to develop the channel database came from the District-furnished hydrographic survey charts of May 1993. This was the latest information available concerning depths, dimensions, and bank lines of the channel. State planar coordinates as shown on the annual survey were used for the definition of the data.

The ship simulator model uses eight equally spaced points to define each cross section. At each of these points, a depth and current magnitude and direction are required. For each cross section, the width, right and left bank slopes, and overbank depths are required. The channel depths at each of the eight points were provided by a TABS-2 model study (Appendix A) conducted simultaneously with the development of the simulation databases that computed the current magnitudes and directions.

The channel side slope and overbank depth are used to calculate bank forces. The shallower the overbank and the steeper the side slope, the greater the computed bank effects. A small difference (1 to 2 ft) in channel bottom and overbank depth produces negligible bank forces and moments.

Visual Scene

The visual scene database was created from the same maps and charts noted in the discussion of the channel. As in the development of the channel database, the state planar coordinate system was used. Aerial and still photographs, video tape, and pilots' comments obtained aboard a transiting integrated tug/barge unit during a reconnaissance trip to Norfolk constituted other sources of information for the scene. These allowed inclusion of the significant physical features and also helped determine which, if any, features the pilots use for informal ranges and location sightings. All aids to navigation such as buoys, channel markers, buildings, docks, docked vessels, towers, dolphins, and tanks were included in the visual scene.

Radar

The radar database is used by the radar software to create a simulated radar for use by the test pilots. The radar database contains x- and y-coordinates that define the border between land and water. The file also contains coordinates for the bank line and any structure on the bank or extending into the water such as bridges and aids to navigation. In short, these data basically define what a pilot would see on a shipboard radar.

Wind

The wind speeds and directions used during the simulation runs were based on consultation with pilots. Wind was not used during simulation of the inbound scenarios because the effect of wind on a loaded vessel is significantly decreased. The winds were chosen based on their frequency and the navigation problems presented. A 20-knot wind from the northeast was used for the Gilmerton Bridge ship scenarios and the I-64 bridge tug/barge scenarios. A 20-knot wind from the northeast and from the northwest was used for the Gilmerton Bridge tug/barge scenarios.

Current

A current database contains current magnitude and direction at eight points across the channel at each of the cross sections defined in the channel. Channel bottom depths are also given at each of these eight points and are included in the channel definition. Interpolation of the data between cross sections provides continuous and smooth current patterns.

The tidal current was derived from the TABS-MD model study. A field data collection effort was required to validate the current model. Appendix A describes both the TABS-MD study and the field data collection. Results from this hydrodynamic model were used to develop the current databases for the existing and proposed conditions.

Test Vessels

The ship files contain characteristics and hydrodynamic coefficients for the test vessels. These data are the computer's definition of the ship, i.e., the ship model. The coefficients govern the reaction of the ship to external forces, such as wind, current, waves, banks, underkeel clearance, and ship/ship interaction; and internal controls, such as rudder and engine revolutions per minute (rpm) commands. In addition, the vessel's image is displayed in the visual scene. The design vessels were chosen based on records of vessel movements and the District's recommendations.

The design ship for evaluating the effects of the two proposed docks and modifications to the Milldam Creek Turning Basin was the same ship used in the previous Elizabeth River study (Webb and Daggett, in preparation). The *El Gaucho*, a 775- by 106-ft bulk carrier, was loaded to a draft of 40 ft for both inbound and outbound transits. The numerical ship model for the *El Gaucho* was developed for a study of the Port of Pascagoula by Tracor Hydronautics, Inc. of Laurel, MD (Ankudinov 1988b).

The design ship for simulations through the Gilmerton Bridges was the *Asian Banner*, a 584- by 94-ft bulk carrier. The *Asian Banner* was loaded to 40 ft for inbound runs and was in ballast (22 ft) for outbound runs. The numerical ship model for the *Asian Banner* loaded to 40 ft was developed for a navigation study of the Sacramento River by Tracor Hydronautics, Inc., of Laurel, MD (Ankudinov 1988a). The numerical ship model for the *Asian Banner* in ballast was developed for the Elizabeth River, Southern Branch, by Designers and Planners, Inc., of Arlington, VA (Ankudinov 1994).

The design tug for the oceangoing integrated tug/barge unit was the *Sea Robin*, a 3000-hp, 106- by 30-ft tug, with an operating draft of 14.5 ft. The barge for the unit was the *T/B ATC 80*. The barge's dimensions were 332 by 74 ft, with a tank depth of 28 ft, a loaded draft of 22 ft, and an empty draft of 4 ft. The numerical ship models for both the loaded and empty tug/barge units were developed by Designers and Planners, Inc., of Arlington, VA (Ankudinov 1994).

Visual representation of the barge image required modification to reflect the difference in barge draft. When the barge is loaded to a draft of 22 ft, only 6 ft of the barge remains above the waterline (Figure 7). However, when the barge is empty, 24 ft of the barge is above the waterline (Figure 8). Limited visibility from the outbound tug's wheelhouse is a significant, real-life navigation problem.

Fender Response Modeling

Improvements to the WES ship/tow simulator's vessel response model were required to calculate vessel motion resulting from an allision with a bridge fender. These improvements were necessary to allow the mariners to slide their vessel along the fender system and to simulate the vessel rebounding after striking a fender. The algorithm required for this modification was developed by Designers and Planners, Inc. of Arlington, VA (Ankudinov 1994).

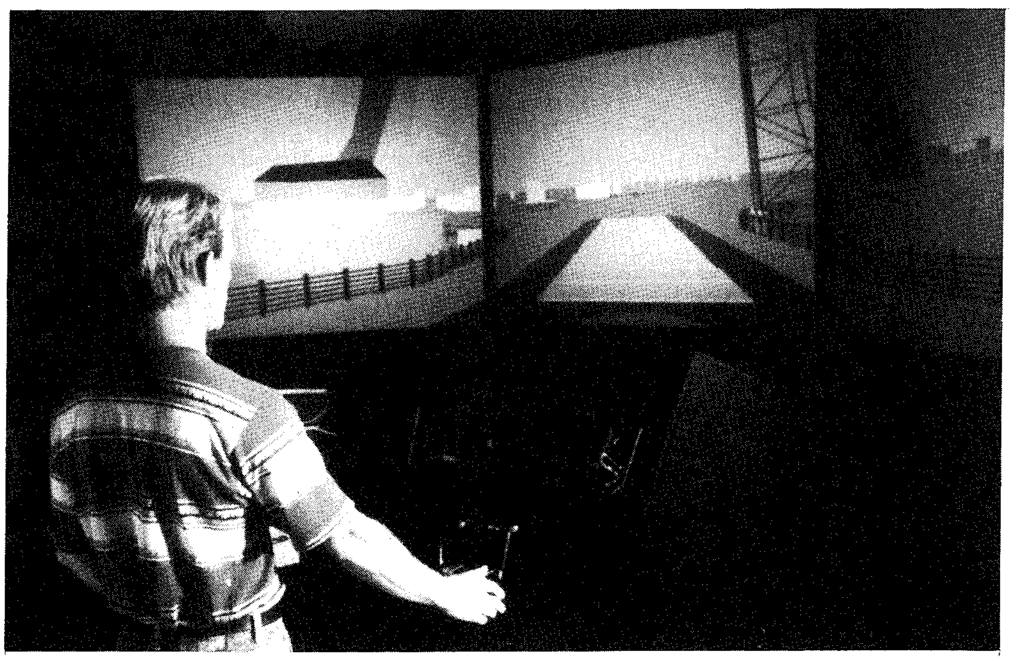


Figure 7. Visual representation of a loaded, inbound barge approaching the Gilmerton Bridges

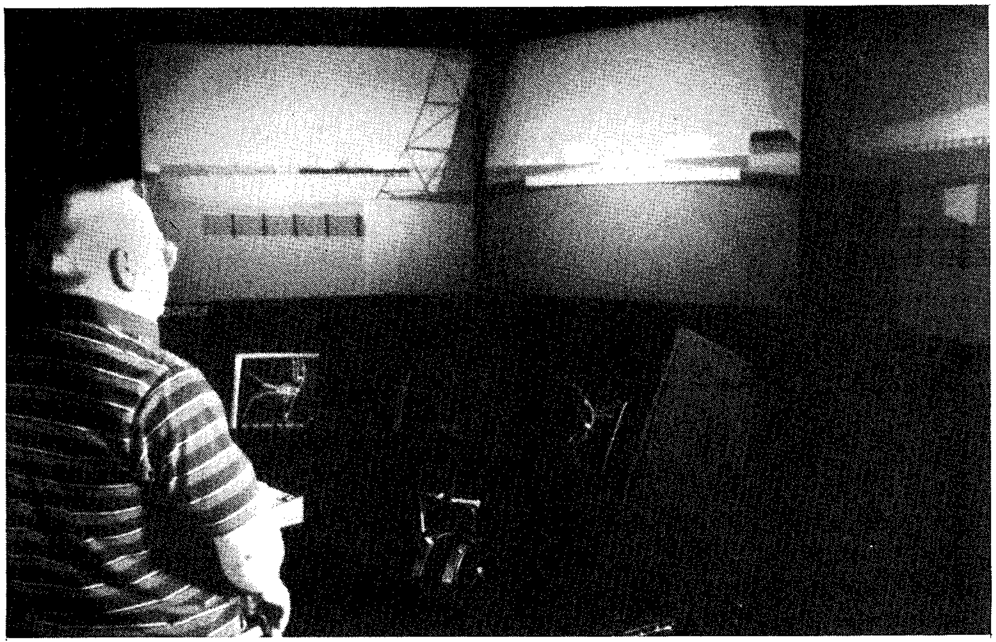


Figure 8. Visual representation of an empty, outbound barge approaching the Gilmerton Bridges

3 Navigation Study

Formal testing was conducted with six professional docking pilots and six professional tug captains licensed for the Southern Branch of the Elizabeth River. Involving local professional pilots incorporated their experience and familiarity with handling ships in the study area in the project navigation evaluation. The tests were conducted in Vicksburg, MS, on the WES ship/tow simulator.

Validation

The simulation was validated with the assistance of two tow captains and one docking pilot licensed for the Southern Branch of the Elizabeth River. The following information was verified and fine-tuned during validation:

a. The channel definition.

(1) Bank conditions.

(2) Currents.

b. The visual scene and radar image of the study area.

(1) Location of all aids to navigation.

(2) Location and orientation of the bridges.

(3) Location and orientation of the docks.

(4) Location of buildings, tanks, and towers visible from the vessel.

(5) Location and orientation of docked barges and vessels.

Initial validation runs were conducted at slack tide and no wind to isolate as many environmental forces as possible. Special attention was given by the pilot to the visual and radar representations and the response of the ship to engine and rudder commands and bank forces. Problem areas were isolated, and the prototype data for these areas were examined. The values for the overbank depth, the side slope, or the bank force coefficient were then adjusted. Simulation runs were then undertaken through the problem areas, and if necessary, further adjustment was made. This process was repeated until the mariners were satisfied that the simulated vessel response to the bank force was similar to that of an actual vessel passing through the same reach in the prototype.

Once the vessel, visual, and bank models were validated, additional validation runs were conducted with both flood and ebb tide. Several simulation runs and subsequent adjustments to the current database were made until the mariners were satisfied that the vessel response to the currents was similar to responses they had experienced in real life.

The only significant adjustment to the current database was for an inbound ship with ebb tide. The validation pilot stated that in real life, he experiences a set to the west when heading inbound through the Gilmerton Bridges during a strong ebb tide. The ebb currents had been validated for the integrated tug/barge unit prior to the ship validation. Examination of the bathymetric data in the area indicated that a ship drafting 35 ft would block enough of the bridge span to force the currents through the eastern side of the bridge. A peninsula on the west prevents currents from being redirected though that side. The effects of a vessel on a flow field are beyond the present state of the art in marine simulation. Therefore, the currents were adjusted to achieve the desired effect. The tug/barge unit and the ship in ballast did not block enough of the bridge span to cause this effect.

Pretesting and Design Phase

Once the simulation models were validated, a pretesting and design program was undertaken to determine which span widths would be included in the full test program, and to select the plan to be tested for the modified Milldam Creek Turning Basin. Two tug captains, one docking pilot, two representatives from the District, and WES representatives participated in the design program. Upon completion of the pretesting/design program, it was agreed that the full test program should include an improved Gilmerton Bridge span of 150 ft and the modified Milldam Creek Turning Basin as shown in Figure 9. It was also agreed that an improved I-64 bridge should be tested with a span of 135 ft and that center-line ranges should be included as part of the improvements.

In order to determine if the ranges would assist mariners in transiting the present 125-ft-span bridge, an additional improvement consisting of the existing I-64 bridge with center-line ranges was added to the test program. This plan will be referred to as Plan 1 and the 135-ft span with center-line ranges as Plan 2.

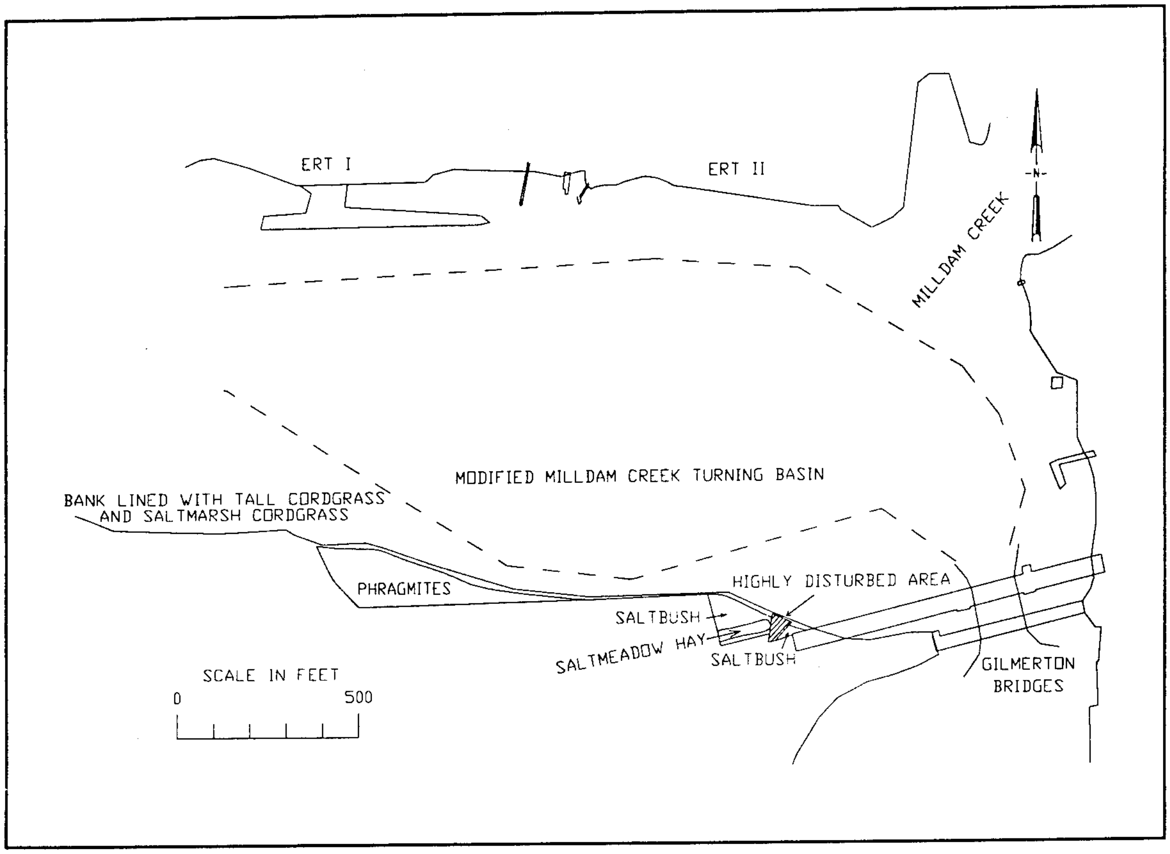


Figure 9. Modified turning basin

Test Procedures

Tests were conducted in a random order. This was done to prevent prejudicing the results as would happen if, for example, all existing conditions were run prior to running the plans. The skill gained at operating the simulator could show the plans tested later in the test program to be easier than they might really be.

During each run, the characteristic parameters of the ship were automatically recorded every 5 seconds. These parameters included the position of the ship's center of gravity, speed, rpm of the engine, heading, drift angle, rate of turn, rudder angle, and port and starboard clearances.

4 Study Results

An analysis of vessel track plots will be presented in order for the Gilmerton Bridge reach, the I-64 bridge reach, and the reach between the Norfolk and Western Railway bridge and the Gilmerton Bridges. Summary tables containing the outcome and important clearances during each test condition are also included. Each table includes a column listing the bridge outcome as either a success or failure. Note that a zero clearance does not necessarily indicate failure. A vessel can slide along the fender system and successfully transit the bridge.

The simulation of turning basin maneuvers tends to be very difficult due to limitations of the animated display of close tolerances from the ship. In real life, a pilot will position one of the ship's mates, or even another pilot, on the bow of the vessel. The person on the bow will use a radio to keep the pilot advised of distances to land, docks, channel markers, etc. Also, the tug captains will use their radios to inform the pilot of closing distances. The 0.25-mile radar display provides some detail of distance information, but not with the accuracy of a skilled crew member. In spite of these limitations, useful information for the sizing of the turning basin can be obtained from simulation runs, even if the ship left the channel. The column "Turning Basin Outcome" in the summary tables indicates whether the vessel was able to negotiate the turn and if it left the channel while doing so. Two distances are presented in the run summary tables for each turning maneuver. The first distance, approximately east-west for the Newton Creek Turning Basin, is the distance perpendicular to the channel that the ship required for the turn. This distance is fairly constant regardless of currents that are aligned with the channel or ship headway. The second distance, approximately north-south for the Newton Creek Turning Basin, is the distance parallel to the channel that the ship required for the turn. This distance is greatly affected by currents and vessel headway.

Vessel Track Plots, Gilmerton Bridge Reach

Individual track plots of all runs conducted in the Gilmerton Bridge reach are shown in Plates 1-115.

Inbound, ebb tide, ships

The track plots for ships making inbound runs in the existing channel with ebb tide are presented in Plates 1-7. Track plots for ships making runs in the proposed channel under the same conditions are shown in Plates 8-13. Summaries of both existing and proposed runs are included as Tables 1 and 2, respectively.

Examination of Tables 1 and 2 shows that three of the seven existing condition runs failed to pass through the Gilmerton Bridge fender system. The main source of the problem (in addition to the narrow span, the bridge being just south of a 90-degree bend, and vessels docked upstream and downstream of the bridge) was the ebb crosscurrents coming around the northeast corner of the bridge. During one of the successful runs (Plate 5), the ship struck both the east and west fender. All of the six proposed condition runs were successful. Clearance to the ship and barges at Chesapeake West increased by nearly 9 ft. Clearance to each fender increased by 12 ft. Clearance to the barge docked on the southern side of the bridges increased by 13 ft.

Turning distances presented in Tables 1 and 2 show that the three completed turns in the existing Newton Creek Turning Basin averaged 600 ft east-west and 1,043 ft north-south. This is the width of the turning basin. However, this average is skewed by one run (Plate 6) with a north-south distance of 1,360 ft. The average north-south distance of the other two runs is 885. One run (Plate 5) failed when the ship grounded on the east side of the turning basin. Because of the increased success in passing through the Gilmerton Bridges, six turns were simulated in the proposed 40-ft-deep Newton Creek Turning Basin. The average east-west distance for the six turns conducted in the proposed turning basin was 612 ft. The average north-south distance was 947 ft.

Inbound, ebb tide, integrated tug/barge units

The track plots for tugs making inbound runs in both the existing and proposed conditions are shown in Plates 14-27. Tables 3 and 4 summarize the existing and proposed condition runs, respectively.

This was the easiest condition tested for the tug traffic, opposing tide with a loaded barge. Opposing tide (heading against the current) is regarded as easier to navigate than fair tide (heading with the current). This is because the opposing tide increases the flow of water past the vessel's rudder, thus increasing steerage. Fair tide decreases the flow of water past the rudder, reducing steerage. In addition, the vessel has to put the propeller in reverse in order to keep from moving with the currents; this makes the thrust and rudders less effective. None of the runs touched the fender system. Clearances increased for the proposed condition by 16 ft for the ship and barge docked at

Table 1
Gilmerton Bridge Reach, Existing Conditions, Inbound, Ebb Tide, *Asian Banner*

				Clearances in Feet					Distance Required in Feet	
Plate	Pilot	Run	Bridge Outcome	Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge	Turning Basin Outcome	East-West	North-South
1	1	1	Failure	108	29	0	N/A	N/A	N/A	N/A
2	1	2	Failure	20	0	11	N/A	N/A	N/A	N/A
3	2	1	Failure	41	0	23	N/A	N/A	N/A	N/A
4	3	1	Success	68	6	7	87	Left Channel	607	970
5	4	1	Success	37	0	0	62	Failure	N/A	N/A
6	5	1	Success	37	13	4	77	Left Channel	586	1,360
7	6	1	Success	57	6	13	43	Left Channel	607	800
Average of Successful Runs				49.8	6.3	6.0	67.3		600	1,043

Table 2
Gilmerton Bridge Reach, Proposed Conditions, Inbound, Ebb Tide, *Asian Banner*

				Clearances in Feet					Distance Required in Feet	
Plate	Pilot	Run	Bridge Outcome	Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge	Turning Basin Outcome	East-West	North-South
8	1	1	Success	63	20	14	122	Left Channel	602	920
9	2	1	Success	61	14	23	60	Left Channel	611	1,004
10	3	1	Success	35	5	30	80	Left Channel	587	954
11	4	1	Success	73	18	15	80	Left Channel	600	790
12	5	1	Success	46	27	18	108	Left Channel	630	960
13	6	1	Success	76	28	10	29	Left Channel	647	1,058
Average of Successful Runs				59.0	18.7	18.3	79.8		612	947

Table 3
Gilmerton Bridge Reach, Existing Conditions, Inbound, Ebb Tide, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet			
				Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
14	1	1	Success	82	29	7	95
15	2	1	Success	78	11	11	167
16	3	1	Success	95	17	12	86
17	4	1	Success	60	19	18	72
18	5	1	Success	46	18	18	50
19	6	1	Success	91	24	7	105
Average of Successful Runs				75.3	19.7	12.2	95.8

Table 4
Gilmerton Bridge Reach, Proposed Conditions, Inbound, Ebb Tide, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet			
				Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
20	1	1	Success	101	43	10	156
21	2	1	Success	88	26	25	76
22	3	1	Success	70	41	23	96
23	4	1	Success	86	29	32	90
24	5	1	Success	86	43	17	80
25	5	2	Success	90	21	25	88
26	6	1	Success	105	28	17	128
27	6	2	Success	108	35	13	131
Average of Successful Runs				91.8	33.3	20.3	105.6

Chesapeake West, 14 ft for the east fender, 8 ft for the west fender, and 10 ft for the barge south of the bridge.

Inbound, flood tide, ships

The track plots for ships making inbound runs in the existing channel with flood tide are presented in Plates 28-35. Track plots for ships making runs in the proposed channel under the same conditions are shown in Plates 36-43. Existing and proposed runs are summarized in Tables 5 and 6, respectively.

Examination of Tables 5 and 6 shows eight successful transits through the Gilmerton Bridges for both existing and proposed conditions. For the existing condition, one run (Plate 28) used both fenders and three runs (Plates 30, 31, and 32) had zero clearance to the west fender. Two runs in the proposed condition (Plates 37 and 39) had zero clearance to the west fender. Clearance to the ship and barges at Chesapeake West increased by nearly 30 ft. Clearance to the east and west fender increased by 14 and 8 ft, respectively. Clearance to the barge docked on the southern side of the bridges increased by 44 ft.

Turning distances presented in Tables 5 and 6 show that the seven completed turns in the existing Newton Creek Turning Basin averaged 636 ft east-west and 809 ft north-south. The average east-west distance for the seven turns conducted in the proposed turning basin is 620 ft. The average north-south distance is 783 ft. One run (Plate 40) failed when the ship was unable to turn into the flood tide.

Inbound, flood tide, integrated tug/barge units

The track plots for tugs making inbound, flood tide runs in both the existing and proposed conditions are shown in Plates 44-57. Tables 7 and 8 summarize the existing and proposed condition runs, respectively.

Six of the seven runs conducted in the existing conditions were successful. One run (Plate 46) failed when the barge struck the west fender. Two runs (Plates 44 and 48) had a zero clearance to the west fender and one run (Plate 50) had a zero clearance to the east fender. All seven of the runs conducted in the proposed condition were successful. Clearances increased for the proposed condition by 15 ft for the ship and barge docked at Chesapeake West, 10 ft for the east fender, 19 ft for the west fender, and increased 10 ft for the barge south of the bridge.

Outbound, ebb tide, wind from the northeast, ships

The track plots for ships making outbound runs in the existing channel with ebb tide are presented in Plates 58-65. Track plots for ships making runs in the proposed channel under the same conditions are shown in Plates 66-75. Identical ships in ballast were used for both existing and proposed tests. Most instances of the ship leaving the authorized channel did not result in grounding because the ballasted draft of the *Asian Banner* is 20 ft. Existing and proposed runs are summarized in Tables 9 and 10, respectively.

Table 5
Gilmerton Bridge Reach, Existing Conditions, Inbound, Flood, *Asian Banner*

				Clearances in Feet					Distance Required in Feet	
Plate	Pilot	Run	Bridge Outcome	Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge	Turning Basin Outcome	East-West	North-South
28	1	1	Success	20	0	0	90	Left Channel	622	820
29	1	2	Success	25	12	8	52	Left Channel	615	932
30	2	1	Success	44	22	0	62	Left Channel	676	750
31	3	1	Success	72	16	0	68	Left Channel	701	950
32	4	1	Success	37	3	0	102	Left Channel	605	802
33	5	1	Success	28	20	3	112	Left Channel	610	650
34	5	2	Success	26	9	8	104	N/A	N/A	N/A
35	6	1	Success	45	8	9	75	Left Channel	620	761
Average of Successful Runs				43.3	11.3	3.5	83.1		636	809

Table 6
Gilmerton Bridge Reach, Proposed Conditions, Inbound, Flood, *Asian Banner*

				Clearances in Feet					Distance Required in Feet	
Plate	Pilot	Run	Bridge Outcome	Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge	Turning Basin Outcome	East-West	North-South
36	1	1	Success	54	21	16	99	Left Channel	599	806
37	2	1	Success	93	31	0	169	Left Channel	650	830
38	2	2	Success	56	27	7	140	Left Channel	618	956
39	3	1	Success	127	24	0	93	Left Channel	618	668
40	4	1	Success	67	26	16	109	Failure	N/A	N/A
41	5	1	Success	29	23	25	129	Left Channel	600	661
42	6	1	Success	92	25	5	168	N/A	N/A	N/A
43	6	2	Success	67	26	21	108	Left Channel	636	780
Average of Successful Runs				73.1	25.4	11.3	126.9		620	783

Table 7
Gilmerton Bridge Reach, Existing Conditions, Inbound, Flood Tide, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
44	1	1	Success	26	20	0	133
45	1	2	Success	107	11	15	84
46	2	1	Failure	42	5	0	N/A
47	3	1	Success	66	29	16	93
48	4	1	Success	46	1	0	138
49	5	1	Success	41	29	6	95
50	6	1	Success	38	0	10	193
Average of Successful Runs				54.0	15.0	7.8	112.9

Table 8
Gilmerton Bridge Reach, Proposed Conditions, Inbound, Flood Tide, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
51	1	1	Success	84	29	20	113
52	2	1	Success	56	15	35	126
53	2	2	Success	103	29	21	102
54	3	1	Success	66	38	28	82
55	4	1	Success	26	22	29	146
56	5	1	Success	73	17	30	106
57	6	1	Success	76	26	28	115
Average of Successful Runs				69.1	25.1	27.3	122.7

This was a difficult test condition to navigate on the simulator. Fair tide reduced the ship's steerage, and the ballasted ship was subjected to wind from the northeast.

Examination of the existing condition summaries in Table 9 shows five successful transits through the Gilmerton Bridges in eight attempts. However, one run (Plate 60) is listed as a success only for the purpose of determining

Table 9
Gilmerton Bridge Reach, Existing Conditions, Outbound, Ebb, *Asian Banner*

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
58	1	1	Failure	N/A	N/A	N/A	55
59	1	2	Success	63	5	0	91
60	2	1	Success[1]	64	5	16	98
61	3	1	Failure	N/A	0	0	0
62	3	2	Failure	N/A	N/A	0	229
63	4	1	Success	91	0	0	96
64	5	1	Success	15	0	0	58
65	6	1	Success	33	0	0	86
Average of Successful Runs				53.2	2.0	3.2	85.8

[1] Success only in terms of bridge clearance values being usable.

Table 10
Gilmerton Bridge Reach, Proposed Conditions, Outbound, Ebb, *Asian Banner*

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
66	1	1	Success	8	9	22	84
67	2	1	Success	11	10	1	76
68	2	2	Success	30	0	0	10
69	3	1	Success	78	3	18	124
70	3	2	Success	32	4	1	75
71	4	1	Success	18	27	3	167
72	5	1	Success	97	10	12	61
73	5	2	Success	28	17	23	83
74	6	1	Success	107	2	0	146
75	6	2	Success	23	8	12	116
Average of Successful Runs				43.2	9.0	9.2	94.2

average clearance through the bridge. The pilot was going too fast and was unable to complete the turn to the west after clearing the bridge span. As a result, his vessel's bow struck the stern of the ship docked at ERT II. This is obviously extremely undesirable. The run that suffered the allision with the ship docked at ERT II was the only run that maintained clearance to both fenders throughout the run. Only one other run (Plate 59) had a clearance to the east fender. All other runs had zero clearances to both fenders.

All runs conducted in the proposed conditions successfully transited the Gilmerton Bridges. One run in the proposed condition (Plate 68) had zero clearance to both fenders. One run (Plate 74) had a zero clearance to the west fender. Clearance to the ship and barges at Chesapeake West decreased by 10 ft. Examination of the proposed condition runs with the lowest clearances (Plates 66 and 67) shows that the pilots were going faster than the other runs. These two vessels were going approximately the same speed as the ship that struck the vessel docked at ERT II, but the extra 25 ft in the bridge span allowed the pilot to complete the turn. Clearance to the east and west fenders increased by 7 and 6 ft, respectively. Clearance to the barge docked on the southern side of the bridges increased by 8 ft.

Outbound, ebb tide, wind from the northeast, integrated tug/barge units

Outbound, with an ebb tide, through Gilmerton Bridges is a condition under which the tugs do not operate in real life. The loss of steerage combined with limited visibility and wind make this a very difficult transit. In actuality, the tug captains will wait at the Huntsman Chemical Dock and time their arrival at Gilmerton Bridges for slack or flood tide. This scenario was added during the second week of integrated tug/barge testing because the captains had completed their required runs and were available for more testing. This scenario was tested to determine if increasing the span of the Gilmerton Bridges would allow the tugs to transit, regardless of tide. The existing condition runs were conducted only during the second week of testing. The proposed condition runs were conducted the second and third week.

The track plots for tugs making outbound runs with ebb tide and wind from the northeast in both the existing and proposed conditions are shown in Plates 76-84. Tables 11 and 12 summarize the existing and proposed condition runs, respectively. One of the three runs conducted in the existing condition was successful, while four of the six runs conducted in the proposed condition were successful.

Outbound, flood tide, wind from the northeast, integrated tug/barge units

The track plots for tugs making outbound runs with flood tide and wind from the northeast in both the existing and proposed conditions are shown in

Table 11
Gilmerton Bridge Reach, Existing Conditions, Outbound, Ebb Tide, Northeast Wind, Integrated Tug/Barge Unit

				Clearances in Feet			
Plate	Pilot	Run	Bridge Outcome	Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
76	3	1	Failure	N/A	1	52	122
77	3	2	Success	84	13	17	134
78	4	1	Failure	N/A	28	0	155
Average of Successful Runs				84	13	17	134

Table 12
Gilmerton Bridge Reach, Proposed Conditions, Outbound, Ebb Tide, Northeast Wind, Integrated Tug/Barge Unit

				Clearances in Feet			
Plate	Pilot	Run	Bridge Outcome	Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
79	3	1	Failure	N/A	0	83	135
80	3	2	Success	75	17	45	145
81	4	1	Failure	N/A	0	109	110
82	4	2	Success	65	19	31	134
83	5	1	Success	65	14	33	20
84	6	1	Success	18	18	40	136
Average of Successful Runs				17.0	17.0	37.3	108.8

Plates 85-100. Tables 13 and 14 summarize the existing and proposed condition runs, respectively.

Five of the seven runs conducted in the existing conditions were successful. One run (Plate 87) had a zero clearance to the west fender. Eight of the nine runs conducted in the proposed condition were successful. One run (Plate 96) failed when the barge struck the west fender while approaching the bridge. The proposed condition increased clearance by 15 ft for the ship and barge docked at Chesapeake West, 8 ft for the east fender, 22 ft for the west fender, and 21 ft for the barge south of the bridge.

Table 13
Gilmerton Bridge Reach, Existing Conditions, Outbound, Flood Tide, Northeast Wind, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
85	1	1	Success	92	25	16	69
86	2	1	Failure	N/A	0	59	210
87	2	2	Success	119	1	0	93
88	3	1	Success	35	4	4	85
89	4	1	Failure	N/A	11	0	87
90	5	1	Success	71	20	22	67
91	6	1	Success	87	23	12	69
Average of Successful Runs				80.8	14.6	10.8	76.6

Table 14
Gilmerton Bridge Reach, Proposed Conditions, Outbound, Flood Tide, Northeast Wind, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
92	1	1	Success	117	2	47	78
93	1	2	Success	105	36	19	142
94	2	1	Success	112	9	26	120
95	2	2	Success	80	15	41	130
96	3	1	Failure	N/A	3	N/A	58
97	3	2	Success	66	31	31	125
98	4	1	Success	96	21	28	106
99	5	1	Success	100	33	37	71
100	6	1	Success	86	32	31	8
Average of Successful Runs				95.3	22.4	32.5	97.5

Outbound, flood tide, wind from the northwest, integrated tug/barge units

The track plots for tugs making outbound runs with flood tide and wind from the northwest in both the existing and proposed conditions are shown in Plates 101-115. Tables 15 and 16 summarize the existing and proposed condition runs, respectively.

Six of the eight runs conducted in the existing conditions were successful. Two of the successful runs (Plates 103 and 108) had a zero clearance to the west fender. Six of the seven runs conducted in the proposed condition were successful. One run (Plate 110) failed when the barge struck the east fender while approaching the bridge. The proposed condition decreased clearances by 10 ft for the ship and barge docked at Chesapeake West, and increased 10 ft for the east fender, 9 ft for the west fender, and 33 ft for the barge south of the bridge.

Vessel Track Plots, I-64 Bridge Reach

Individual track plots of all runs conducted in the I-64 bridge reach are shown in Plates 116-186. Composite plots of runs within the I-64 fender system are shown in Plates 187 and 188. Table 17 summarizes the average clearances for each condition.

Inbound, ebb tide

The track plots for integrated tug/barge units making inbound runs with ebb tide are presented in Plates 116-132. None of the runs in the existing or the two proposed conditions came in contact with the bridge fender system. The average clearance to the east fender increased from 19 ft for the existing to 22 ft for Plan 1 and to 23 ft for Plan 2. Average clearances to the west fender were 15 ft for the existing condition, 28 ft for Plan 1, and 29 ft for Plan 2. Examination of the composite plot (Plate 187) shows that the runs conducted with ranges (Plans 1 and 2) stayed in the middle of the span more than the existing condition runs.

Inbound, flood tide

The track plots for integrated tug/barge units making inbound runs with flood tide are presented in Plates 133-150. None of the runs in the existing or two proposed conditions touched the bridge fender system. One run in Plan 2 (Plate 140) came within 6 ft of the east fender because the tug's captain waited too long to make the turn. Although the vessel shown in Plate 140 left the authorized 35-ft-deep channel north of the bridge, the barge (which was loaded to 22 ft) would not have run aground. Average clearances to the east fender

Table 15
Gilmerton Bridge Reach, Existing Conditions, Outbound, Flood Tide, Northwest Wind, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
101	1	1	Success	73	20	20	93
102	2	1	Failure	N/A	0	0	104
103	2	2	Success	145	8	0	53
104	2	3	Failure	N/A	6	0	42
105	3	1	Success	82	12	18	172
106	4	1	Success	92	4	8	96
107	5	1	Success	66	10	19	65
108	6	1	Success	104	6	0	66
Average of Successful Runs				93.7	10.0	10.8	90.8

Table 16
Gilmerton Bridge Reach, Proposed Conditions, Outbound, Flood Tide, Northwest Wind, Integrated Tug/Barge Unit

Plate	Pilot	Run	Bridge Outcome	Clearances in Feet: Ship and Barges at Chesapeake West	East Fender	West Fender	Barge South of Bridge
109	1	1	Success	111	28	26	101
110	2	1	Failure	N/A	0	88	112
111	2	2	Success	95	4	11	232
112	3	1	Success	77	11	21	155
113	4	1	Success	64	18	0	85
114	5	1	Success	73	23	37	98
115	6	1	Success	83	34	22	72
Average of Successful Runs				83.8	19.7	19.5	123.8

were 23 ft for the existing condition, 25 ft for Plan 1, and 24 ft for Plan 2. Average clearances to the west fender increased from 23 ft for the n xisting condition, to 25 ft for Plan 1, to 31 ft for Plan 2. Examination of the composite plot (Plate 187) shows that the runs conducted in Plan 1 were more

Table 17
Interstate 64 Bridge, Run Summaries

Condition	Span Width, ft	Ranges	Heading	Wind	Tide	Average Clearance in Feet	
						East Fender	West Fender
Existing	125	No	Inbound	No	Ebb	19	15
Plan 1	125	Yes	Inbound	No	Ebb	22	28
Plan 2	135	Yes	Inbound	No	Ebb	23	29
Existing	125	No	Inbound	No	Flood	23	23
Plan 1	125	Yes	Inbound	No	Flood	25	25
Plan 2	135	Yes	Inbound	No	Flood	24	31
Existing	125	No	Outbound	Northeast	Ebb	25	14
Plan 1	125	Yes	Outbound	Northeast	Ebb	22	28
Plan 2	135	Yes	Outbound	Northeast	Ebb	18	35
Existing	125	No	Outbound	Northeast	Flood	28	17
Plan 1	125	Yes	Outbound	Northeast	Flood	24	24
Plan 2	135	Yes	Outbound	Northeast	Flood	25	28

closely grouped and stayed in the middle of the span more than either the existing condition or Plan 2.

Outbound, ebb tide, northeast wind

The track plots for integrated tug/barge units making outbound runs with ebb tide are presented in Plates 151-168. None of the runs in the existing or two proposed conditions came in contact with the bridge fender system. However, two runs (Plates 154 and 156) in the existing channel came within 3 ft of the west fender. The closest any of the Plan 1 runs came to the bridge is shown in Plate 164, where the vessel came within 7 ft of the east fender. The closest any of the Plan 2 runs came to the bridge is shown in Plate 158, where the vessel came within 3 ft of the eastern fender. The average clearances to the east fender were 25 ft for the existing condition, 22 ft for Plan 1, and 18 ft for Plan 2. The average clearances to the west fender were 14 ft for the existing condition, 28 ft for Plan 1, and 35 ft for Plan 2. The composite plot (Plate 188) shows both plans having a tighter grouping and closer to the east fender than the existing condition.

Outbound, flood tide, northeast wind

The track plots for integrated tug/barge units making outbound runs with flood tide are presented in Plates 169-186. None of the runs in the existing or two proposed conditions came in contact with the bridge fender system. However, two runs in the existing condition (Plates 170 and 174) came within 6 ft and 9 ft of the west fender, respectively. The minimum clearance for Plan 1 runs was 12 ft to the west fender (Plate 182). The minimum clearance for Plan 2 runs was 14 ft to the east fender (Plate 177). The average clearances to the east fender were 28 ft for the existing condition, 24 ft for Plan 1, and 25 ft for Plan 2. The average clearances to the west fender were 17 ft for the existing condition, 24 ft for Plan 1, and 28 ft for Plan 2. The composite plot (Plate 188) shows both plans having a tighter grouping and closer to the east fender than the existing condition.

Vessel Track Plots, NWRB to ERT Reach

Composite and individual track plots of all runs conducted in the reach from the NWRB to the Milldam Creek Turning Basin are shown in Plates 189-216.

Inbound, flood tide, Milldam Creek Turning Basin

The composite track plot for the *El Gaucho* making inbound runs with flood tide is presented in Plate 189. Individual runs are presented in Plates 190-198. None of the track plots show the pilots having any difficulty with the two proposed docks. Of the nine runs conducted under these conditions, four were made without any problem. On the other five runs, the pilot left the channel at different locations. However, the incidents of leaving the channel show no recurring pattern that would indicate a problem with the channel plan. One pilot waited too long to make the turn to starboard after passing through the NWRB, leaving the channel and nearly hitting the channel marker (Plate 197). However, he repeated the run (Plate 198) and successfully negotiated the turn. Two of the runs (Plates 193 and 194) show the vessels leaving the western side of the channel across from Tenneco Dock by 15 and 45 ft, respectively. One run (Plate 194) left the channel on the eastern side south of the Hess Ship Dock by 125 ft. Three runs (Plates 191, 192, and 193) left the western side of the channel north of St. Julian Creek. The run shown in Plate 191 left the channel by 50 ft, the other two runs by approximately 20 ft each. However, there is deep water in front of the abandoned pier just north of St. Julian Creek and none of these runs would have grounded.

Evaluation of the turning portion of these runs reveals that of the eight runs in which the turning maneuver was completed, five were done without any problem and three runs (Plates 192, 195, and 197) left the authorized turning basin. The run in Plate 192 left the southern edge of the basin by 20 ft. The run in Plate 197 left the southern edge of the basin by 25 ft. If either of these pilots had started their turn further west, the runs would have remained within the basin limits. Both pilots repeated the run successfully, as shown in Plates 193 and 198, respectively. The run shown in Plate 195 left the basin by

175 ft and was caused by the pilot not starting his turn further west. The area required for this turn did not exceed the area available in the turning basin. In evaluating these turning maneuvers, runs leaving the channel near the ship docked at ERT II are not considered as having an adverse incident. One run (Plate 190) was aborted prior to the turn due to equipment failure.

Inbound, flood tide, St. Julian Creek Turning Area

The composite track plot for the *El Gaucho* making inbound runs with flood tide is presented in Plate 199. Individual runs are presented in Plates 200-207. These plots show none of the vessels leaving the channel prior to the St. Julian Creek Turning Area. One run (Plate 205) touched the western edge of the channel across from the Tenneco Dock, but did not leave the channel.

Five of the seven turns attempted in the St. Julian Creek Turning Area were successful, while two failed. The first failed run (Plate 203) ended when the ship struck the Atlantic Energy Pier, and the other (Plate 205) when the vessel went aground on the north side of St. Julian Creek. One run (Plate 200) was aborted prior to the turn due to equipment failure. Turning in the St. Julian Creek Turning Area requires that the vessel leave the channel and use deep water in the creek and the area in front of Atlantic Energy. Only one turn (Plate 201) was completed with the ship leaving the channel in only those areas. This ship came within 20 ft of the Atlantic Energy Dock.

Outbound, ebb tide

The track plots for the *El Gaucho* making outbound runs with ebb tide are presented in Plates 208-216. Of these eight runs, three were completed without any incident of leaving the channel. Two of the runs (Plates 210 and 211) slightly left the channel near the International Matex Tank Terminals (IMTT) dock by 30 ft and 10 ft, respectively. The pilots of two of the runs (Plates 213 and 216) waited too long to make the turn to starboard near the proposed docks. One run (Plate 214) left the east side of the channel across from St. Julian Creek.

The most serious incident is shown in Plate 213; the *El Gaucho* came within 10 ft of the ship docked at the proposed western pier. The incident occurred because the pilot waited too long to make the turn to port near the Hess Barge Dock (nearly leaving the authorized channel) and was out of position to make the turn to starboard.

The run shown in Plate 216 left the channel by 20 ft just south of the proposed western pier. This resulted in his being out of position to make the next turn and leaving the channel by 60 ft on the eastern side. One run (Plate 214) left the channel by 20 ft on the eastern side, just south of the NWRB. This occurred because the pilot waited too long to turn.

Questionnaires

The mariners were given two types of questionnaires during the study. One questionnaire was given after each simulation run, and the other, a final questionnaire, was given to the mariner upon completion of all required simulation tests.

Upon completion of each run, the mariner was asked to rate various "dangers" encountered during the test on a scale from 0 to 10, with 10 being the most dangerous. If the mariner felt that the dangers encountered during the run were the same as would be encountered in real life under similar conditions, he was instructed to rate that condition as a 5. Results from the questionnaire given after each run are plotted as an average of all responses. Due to space limitations on the chart, the questions are numbered rather than written in their entirety for the Gilmerton Reach. Questions 1 through 6, for inbound runs, are as follows:

1. Danger of hitting a vessel north of the bridge.

2. Ability to get vessel aligned for the bridge.

3. Danger of hitting the bridge fender system.

4. Danger of hitting barge south of the bridge.

5. Ability to make starboard turn south of the bridge.

6. Ability to turn vessel in basin (ships only).

Questions 1 through 5, for outbound runs, are as follows:

1. Danger of hitting barge south of the bridge.

2. Ability to get vessel aligned for the bridge.

3. Danger of hitting the bridge fender system.

4. Danger of hitting a vessel north of the bridge.

5. Ability to make port turn north of the bridge.

Docking pilots, Gilmerton Bridge

The average docking pilot ratings for the Gilmerton Bridge area are presented in Figures 10-12. The pilots' ratings show that they felt that the proposed widened bridge span improved navigation for all questions.

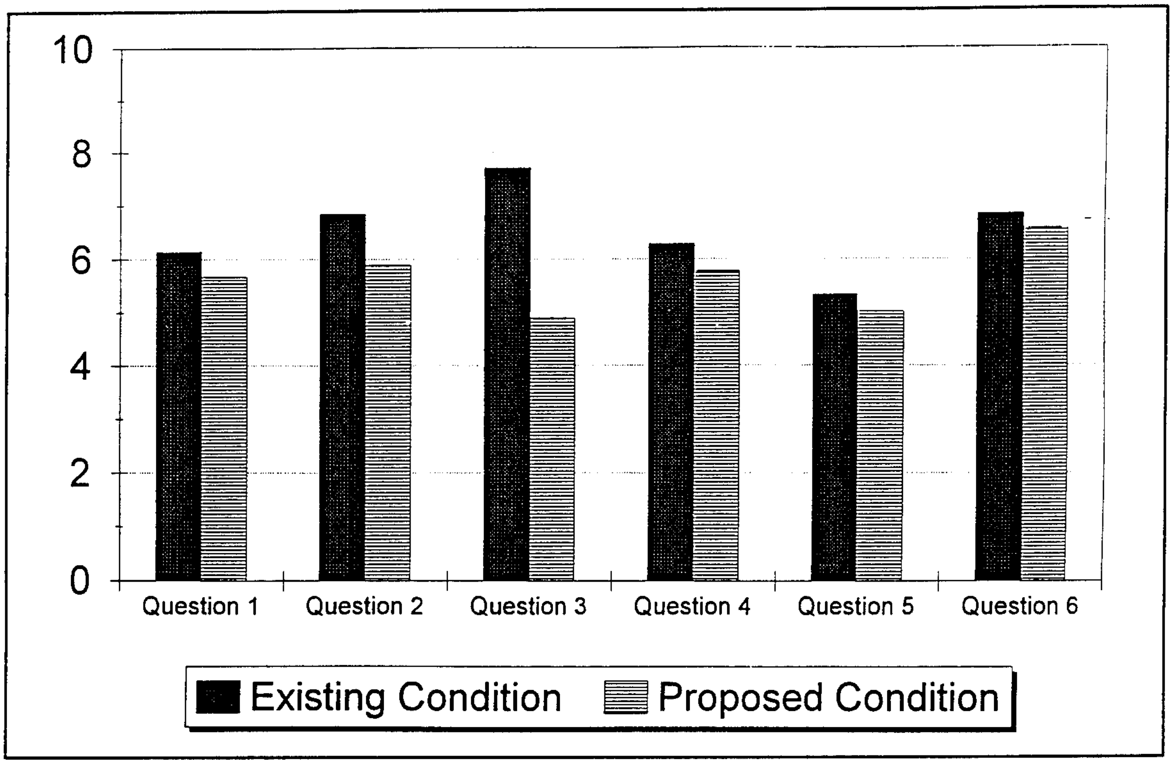


Figure 10. Docking pilots' ratings, Gilmerton Bridge, inbound, ebb

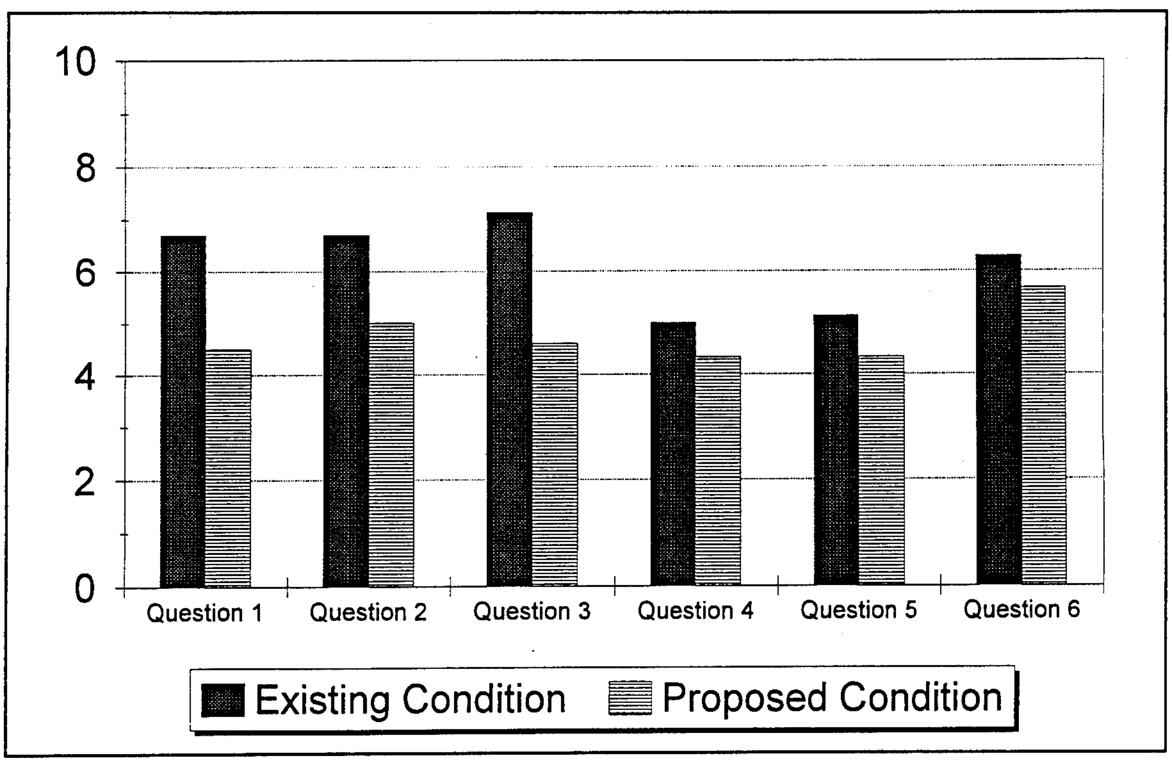


Figure 11. Docking pilots' ratings, Gilmerton Bridge, inbound, flood

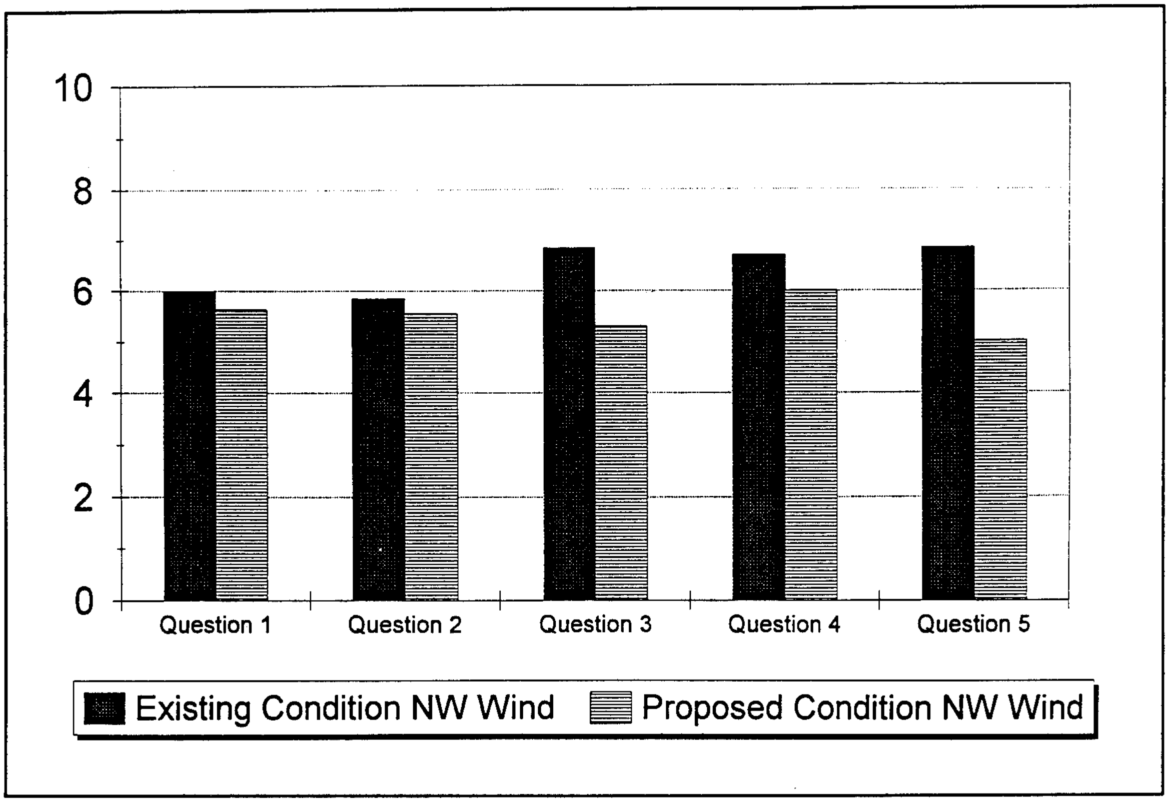


Figure 12. Docking pilots' ratings, Gilmerton Bridge, outbound, ebb

Tug captains, Gilmerton Bridges

The average tug captain ratings for the Gilmerton Bridges area are presented in Figures 13-16. These ratings show that the tug captains thought that the proposed changes significantly improved navigation conditions.

Tug captains, I-64 bridge

The average tug captain ratings for the I-64 bridge area are presented in Figures 17-20. These ratings show that the tug captains thought both Plans 1 and 2 improved navigation through the I-64 bridge. The improvement between the existing condition and Plan 1 was perceived to be greater than between the two plans.

Docking pilots, final questionnaire

1. Please describe the navigation problems presently associated with 125-ft Gilmerton Bridges.

With most ships, the bridge opening is too narrow to have tugs alongside a ship going through the bridge.

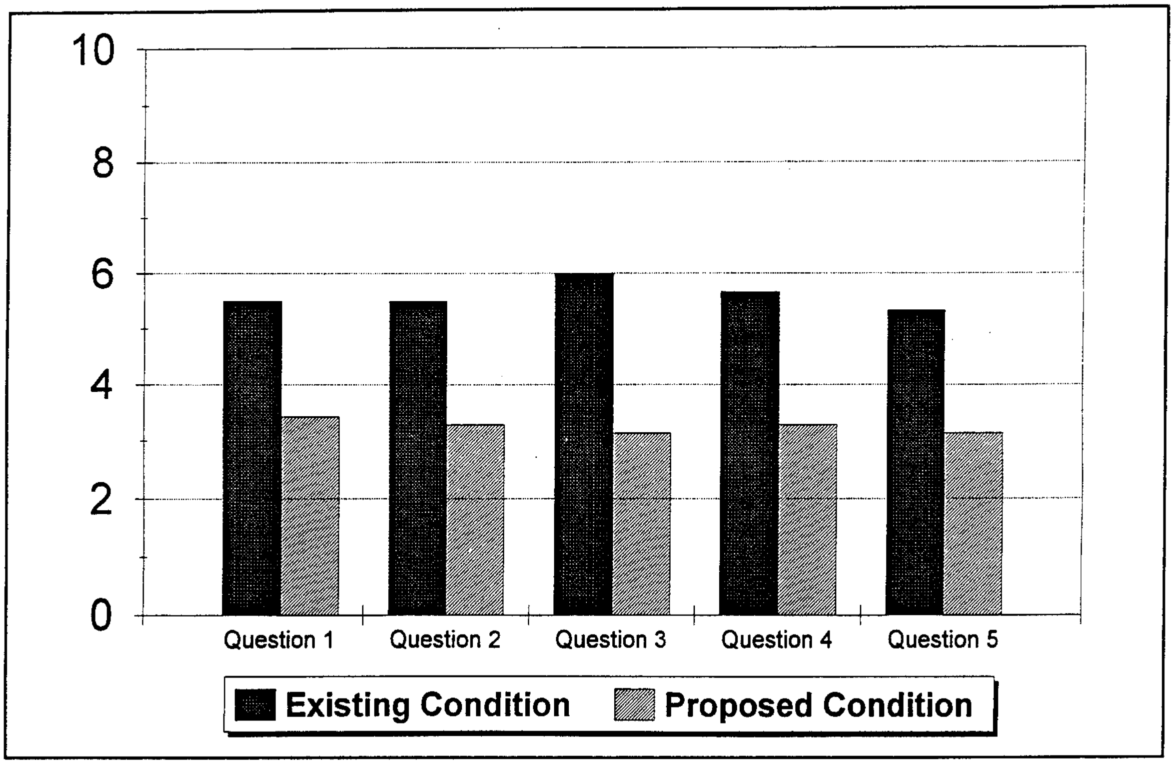


Figure 13. Tug captains' ratings, Gilmerton Bridge, inbound, ebb

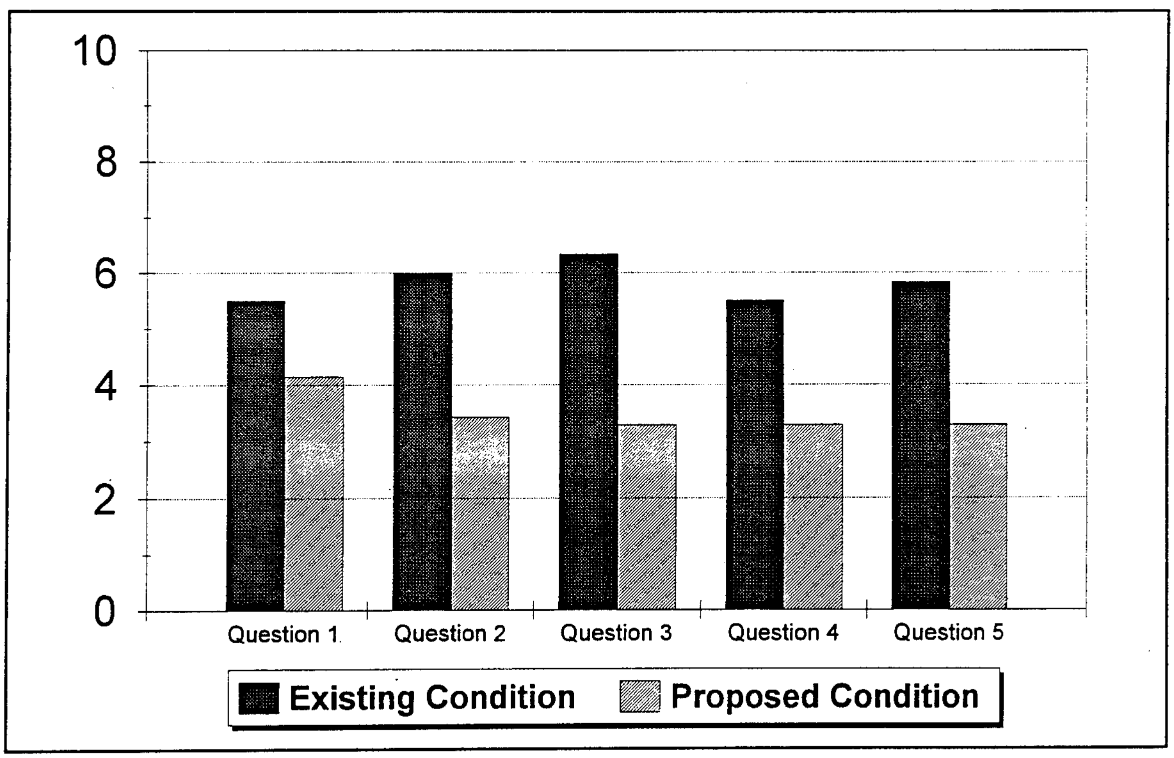


Figure 14. Tug captains' ratings, Gilmerton Bridge, inbound, flood

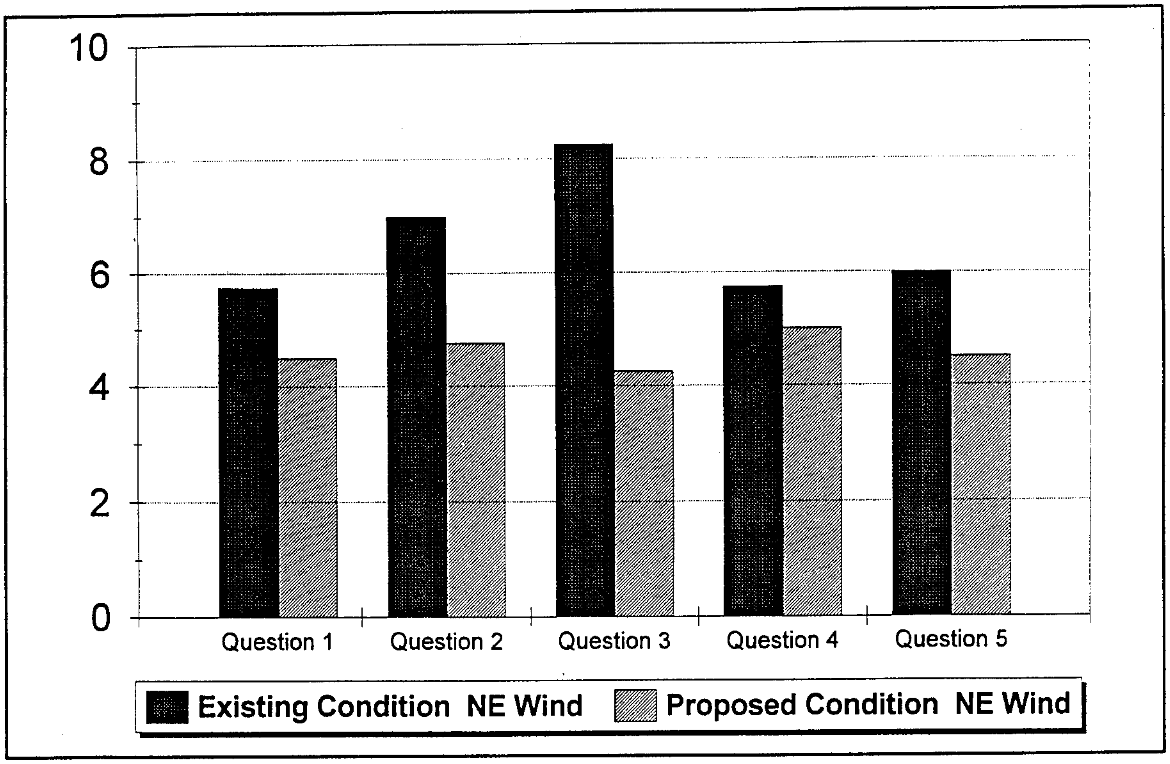


Figure 15. Tug captains' ratings, Gilmerton Bridge, outbound, ebb

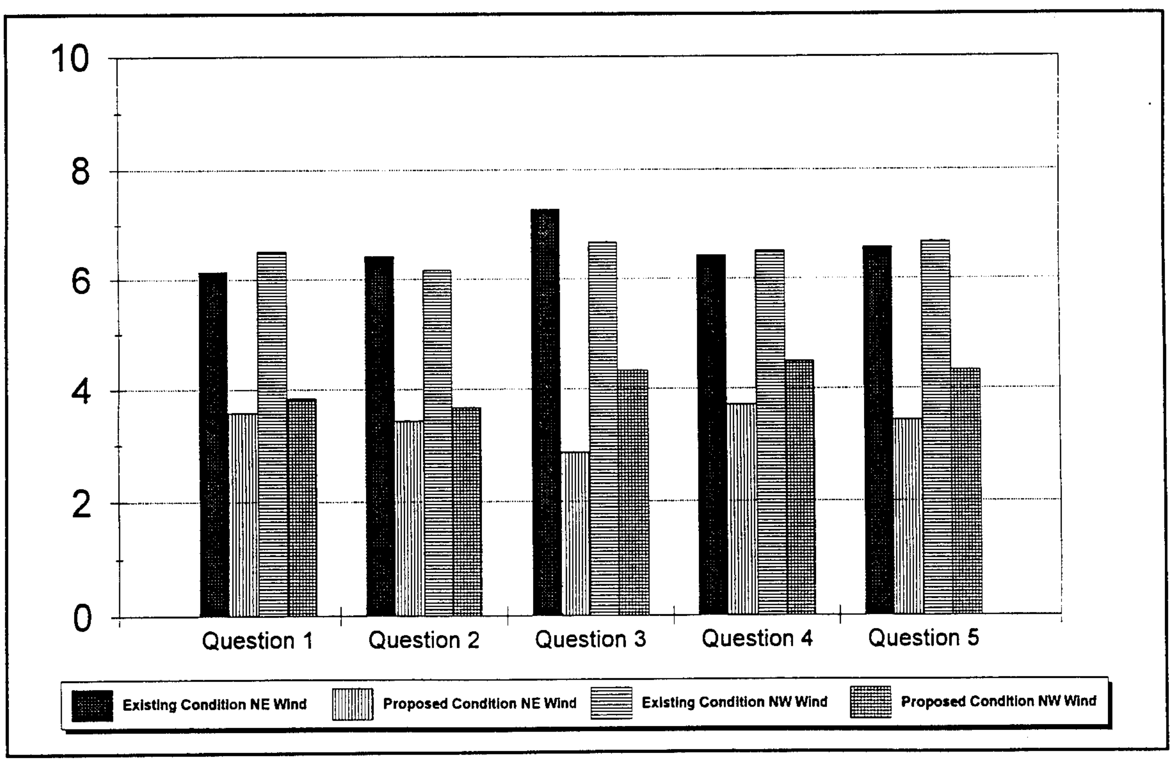


Figure 16. Tug captains' ratings, Gilmerton Bridge, outbound, flood

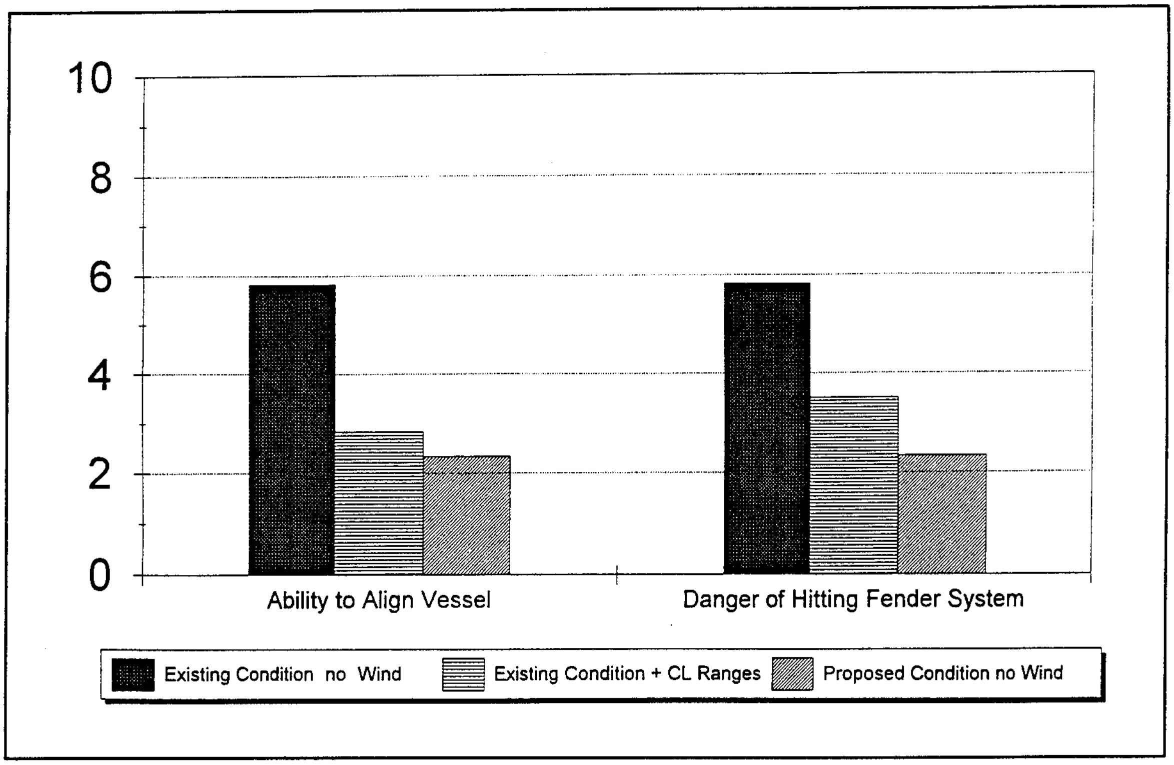


Figure 17. Tug captains' ratings, I-64 bridge, inbound, ebb

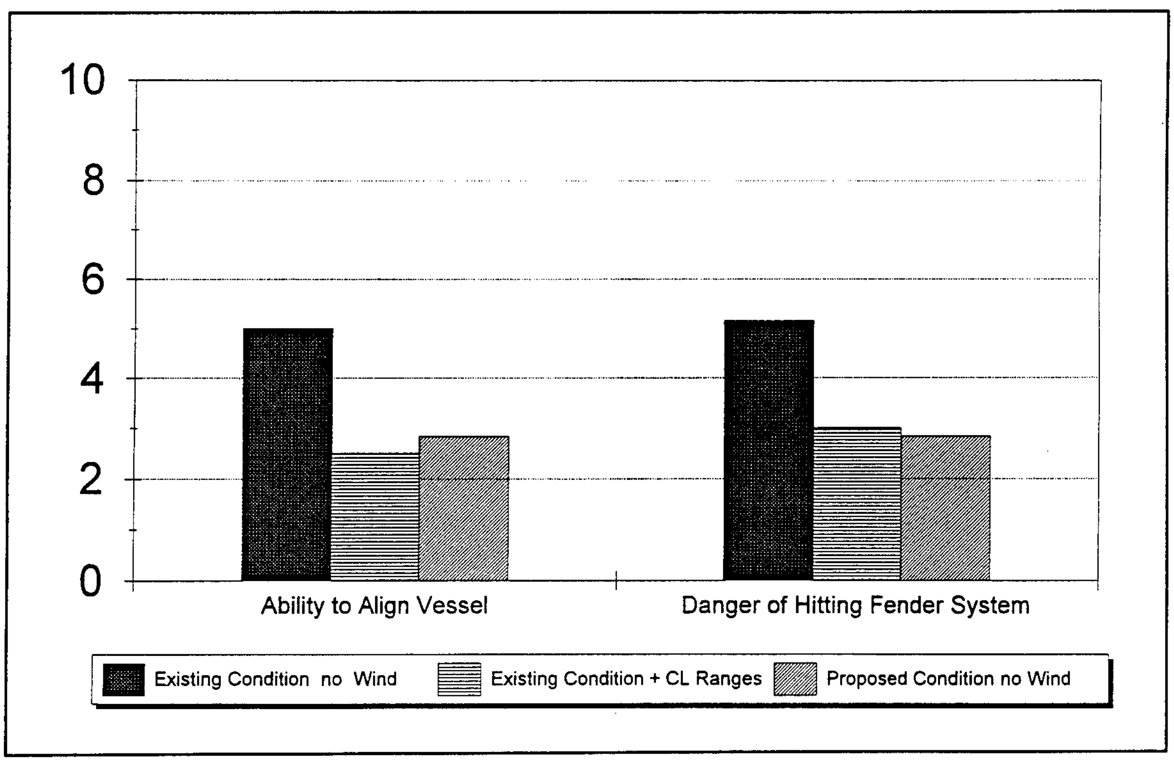


Figure 18. Tug captains' ratings, I-64 bridge, inbound, flood

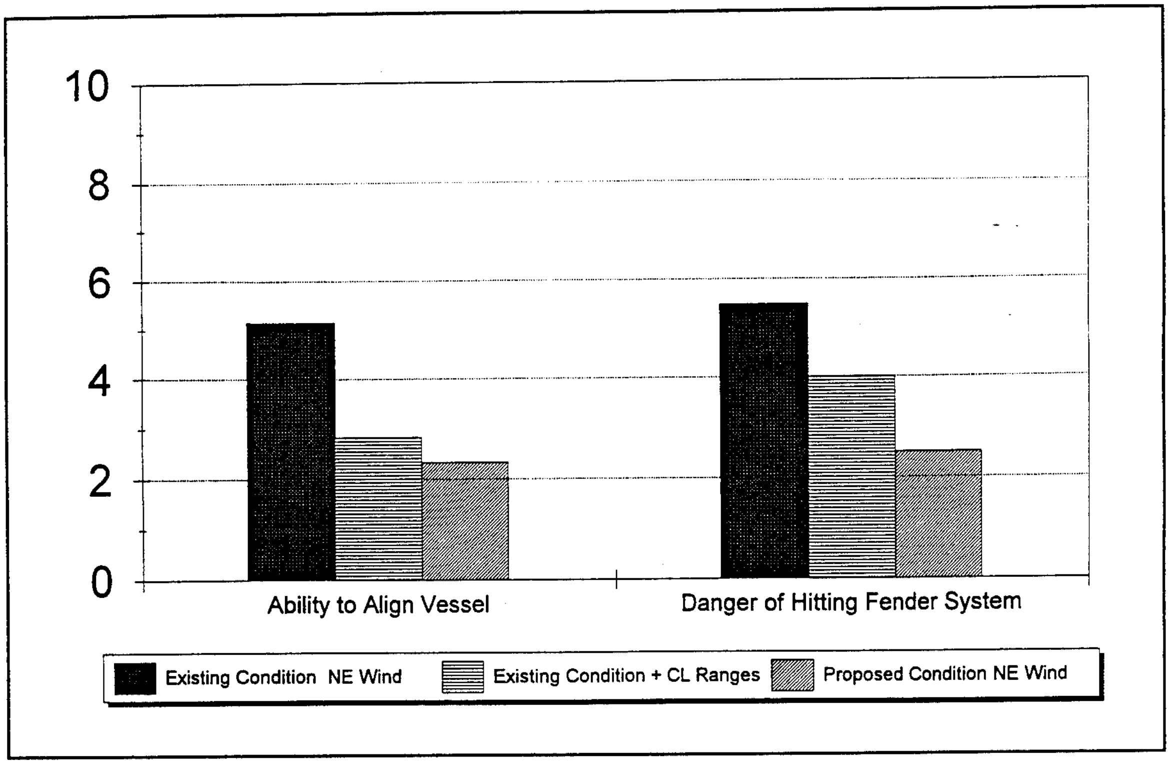


Figure 19. Tug captains' ratings, I-64 bridge, outbound, ebb

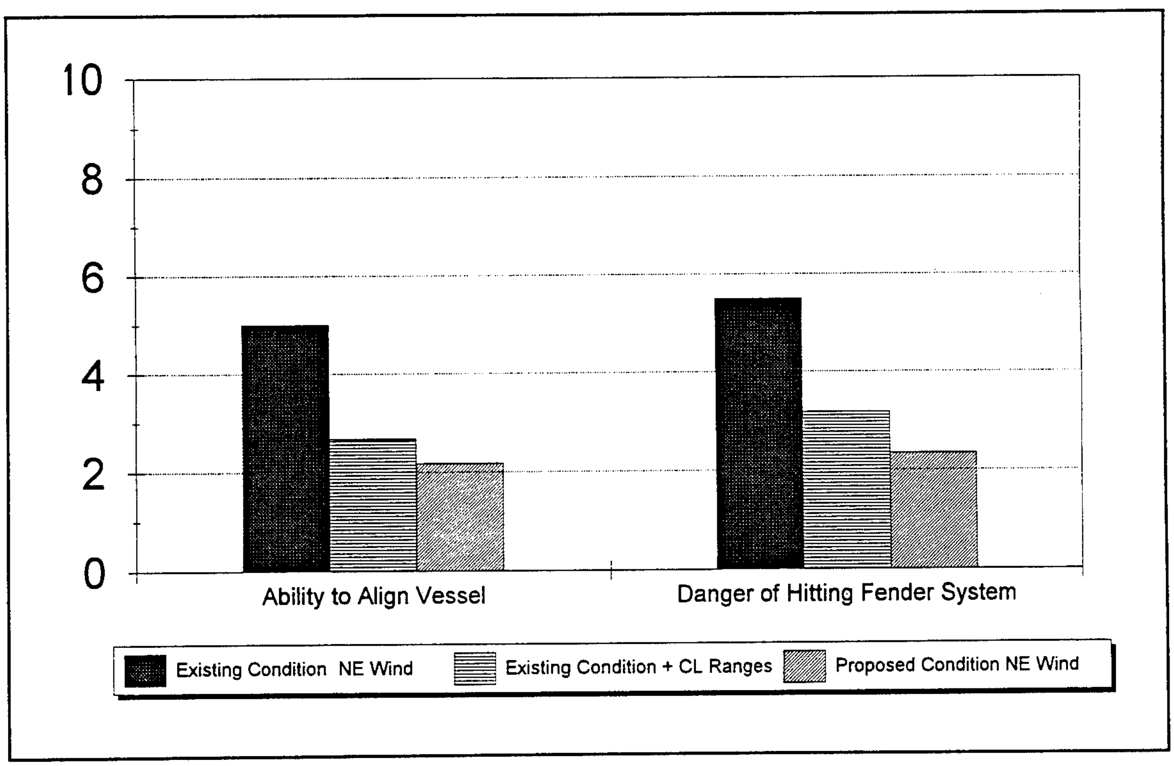


Figure 20. Tug captains' ratings, I-64 bridge, outbound, flood

A large vessel moored north of the bridge prevents proper lineup for the bridge.

You can't get lined up with the bridge with a ship of that size with ships on north and south side.

Width of bridge limits tug use going through bridge. Bridge is located on very tight bend.

Not enough room to keep tug alongside going through. If there is a ship at Chilean nitrate very close.
No room on south side to make turn to starboard.
Ebb current, southwest wind very tricky to line up and come through.
No turn space north of bridge outbound.
Piers south of bridge should be empty-no barges!

Ships and barges tied up north and south of bridge.
Very little clearance when no barge or ship is present.

610-ft vessel inbound and outbound ERT to Vepco turning basin.
775-ft vessel inbound and outbound old Virginian RR Bridge to ERT turns in existing turning basin and proposed Milldam Creek Turning basin.

2. Based on your simulator runs, does the proposed 150-ft Gilmerton Bridge rectify these problems?

Is improved drastically.

Is rectified.

Yes, but another 30 ft would be a lot better. I would try 180 ft.

It might make it a little better but I would say it doesn't rectify the problem.

Yes

Yes, the additional 25' would increase safety. Plus it would allow us to better utilize the tugs with the size ships presently trafficking the area.

I feel that 150-ft span compared to 125-ft span greatly increases safety of ship traffic through the Gilmerton Bridge.

3. Based on your simulator runs, does the proposed terminal on the eastern side of the Elizabeth River present any navigation problems?

No problem.

No.

On the simulator the proposed terminal on eastern side seemed to go very well. I didn't see any danger above ordinary.

No. Except at turn basin (proposed) makes for very controlled tight turn at 775-ft ship. 750-ft ship would be a lot easier.

No.

It will only make the turn look worse visually because you still have the same amount of channel size. Would only make a difference outbound in the case of a steering or engine loss. You would hit vessels on west side of channel instead of running aground.

4. Based on your simulator runs, does the proposed terminal on the western side of the Elizabeth River present any navigation problems?

No problem.

No.

I would say same answer as question #3.

No.

No, anytime you have a terminal on the outside of a bend it runs a greater risk than one on the other side.

No.

5. Based on your simulator runs, what is your opinion of the proposed Milldam Creek Turning basin?

It is well planned and could easily handle the size ship used on simulator.

It would be OK.

I would say OK for ships under 700 ft or 650 ft. It would work OK. For larger ships you would be pushing it.

If there is a ship in ERT #2 would limit ship length to 750 ft.

It would be helpful for area traffic especially with a ship berthed at Atlantic Energy.

I think that it would be very helpful for ship traffic in that area. Especially for vessels berthing and unberthing at ERT and Chesapeake west.

6. Based on your simulator runs, what is your opinion of turning 40-ft-draft vessels in the St. Julians Creek turning area?

No problem.

It would depend on the length of the ship and if other ships are in the fuel dock.

It seemed to work OK on simulator, but not much room for error.

This was done quite easily with buoys #17 can and #19 pa moved east as simulator shows.

No different than 35 ft.

No different than 35 ft.

7. Any additional comments on the navigation study?

The widening of the channel between the proposed east and west berths would give more places to meet traffic on the southern branch.

I suppose this is the best way to find answers. I sure don't know the answer.

Adding 25 ft horizontal clearance to Gilmerton Bridge will make everybody who has to transit happy.

The turning basin (proposed) will cut down on transit time. Moving #10,12,14 to the west will make safer transit.

I think this is a valuable tool.

No.

Tug captains, final questionnaire

1. Please describe the navigation problems presently associated with 125-ft Gilmerton Bridge.

125-ft span allows limited assist tug use while transiting span.

All transits must be done on slack water or opposing tides due to current sets and railroad traffic delays. Both bridge (R.R. and Gilmerton) spans are located in a 90-degree turn. We must use assist tugs to turn immediately after span is complete.

The bridge span is too small.

125-ft span is hard to get lined up inbound and worst to line up outbound with wind blowing.

Fender system too narrow.

Having to make sharp turn before the bridge does not give time to line up with opening, docks north and south of bridge limit maneuvering room. Very often the bridge will close as you are approaching bridge.

2. Based on your simulator runs, does the proposed 150-ft Gilmerton Bridge rectify these problems?

It doesn't completely solve all the problems. Much better transiting with assist tugs through draw. The 150-ft span would be a asset while in transit through draw. The existing 90-degree turn will still require a very slow speed. Also the unexpected closing of the RR Bridge will still be a factor. Alignment and transit will be much better.

It will help yes.

It is easier to make bridge with 150-ft width, but I still would wait for slack tide.

No, but it does make passage much easier.

3. Please describe the navigation problems presently associated with the 125-ft Interstate Bridge.

Very narrow span and bridge span create an illusion to location of draw and fender system.

The bridge span is now 125 which I think is too narrow, and no ranges to line up on center line outbound with wind affecting the bridge.

Fender system too narrow and no ranges.

Bridge is not perpendicular to range, this makes it hard to line up on bridge.

4. Based on your simulator runs, does the proposed 135-ft I-64 Bridge, with inbound and outbound ranges, rectify these problems?

Very much so.

Yes, it would help a lot. The span wider plus the help of the ranges to hold on the center line.

Yes.

Yes, Ranges allow you to line up on bridge and to correct for any set.

5. Do the center-line ranges improve navigation for the existing 125-ft Interstate Bridge?

Yes.

Yes, it does help a lot. It helps to line up on the bridge.

Yes, but fender system needs to be 135 ft.

Yes.

6. Any additional comments on the navigation study?

If possible the realignment of the Elizabeth River channel to remove the existing 90-degree turn would have been a great asset. (Gilmerton Bridge) I understand the mechanics involved would have been too great.

I think that the study on the Elizabeth River was good to improve the waterway, the Gilmerton Bridge needs to be improved. Also the interstate bridge needs to be improved.

Gilmerton and Interstate fenders need to be wider, they are a navigational problem.

5 Conclusions and Recommendations

Based on the results of the real-time navigation study the following conclusions can be drawn:

a. Widening the Gilmerton Bridge span from 125 to 150 ft significantly reduced the number of adverse incidents for both ships and integrated tug/barge units transiting the area. Vessels operating in the proposed conditions were able to stay farther away from the vessels and barges docked on the eastern side of the channel because the 25-ft widening was all on the western side.

b. The modified Milldam Creek Turning basin, as tested in the real-time program, is of sufficient size to turn the 775- by 106-ft design ship. Test results show turns in the ERT basin had fewer incidents (both in number and severity) than those conducted in the St. Julian Creek Turning Area. Test runs that left the proposed Milldam Creek Turning Basin limits did so because the pilot waited too long to start the turning maneuver. This is understandable because it was the first time the pilots had turned a vessel in this area, and timing is critical in this type of maneuver. Of the three pilots who waited too long, two had an opportunity to repeat the run. Both of these pilots successfully turned the ship on their second chance.

c. The proposed dock located on the eastern side of the channel had no apparent effect on navigation.

d. The proposed dock located on the western side of channel is on the outside of the bend, and is therefore in a position of some risk because outbound vessels head directly toward the dock prior to the starboard turn. Inbound vessels present no risk for a ship docked at this facility. It should be noted that on the final questionnaire, none of the pilots opposed construction of either proposed terminal. The only concern mentioned was in case of a steering or engine loss.

e. Of the 25 runs on the reach between the NWRB and the Gilmerton Bridges, most were successfully completed without the ship leaving the channel. For the 17 inbound runs, the five runs leaving the channel were all to the proposed Milldam Creek Turning Basin. Although the channels were identical, none of the runs going to the St. Julian Creek Turning Area left the channel. The ships going to St. Julian Creek were traveling slightly slower than those going to the Milldam Creek Turning Basin (in anticipation of the early turn); perhaps the slower speed improved the performance. Several of the outbound runs also crossed the channel limits. However, most of these would not have run aground. It should also be noted that in real life, ships transit this reach with assist tugs alongside. The WES ship/tow simulator, as was configured for the tests described in this report, has certain limitations for tug usage. During the simulator runs, tugs cannot be moved from one location to another or operate at an angle to the ship. Typically, this is not a problem for turning maneuvers, because the simulator tugs are operating as they would in real life, perpendicularly to the ship. It is likely that a portion of the simulator runs between the NWRB and the turning maneuver would have benefited from increased tug usage.

f. The Newton Creek Turning Basin is barely large enough to turn a 584- by 94-ft ship.

g. Widening the I-64 bridge span from 125 ft to 135 ft (and installing center-line ranges) improved clearances to the fender system. A more significant improvement in clearances was seen between the existing 125-ft span and the 125-ft span with ranges (Plan 1) than between the 125-ft span with ranges (Plan 1) and the 135-ft span with ranges (Plan 2).

Based on the results of the real-time navigation study, the following recommendations are made:

a. Improvements to the Gilmerton Bridge should include increasing the span to a minimum width of 150 ft. The widening should be on the western side of the channel.

b. The existing 35-ft channel from the NWRB to the Gilmerton Bridges should be deepened and widened as proposed, and the Milldam Creek Turning Basin (as shown in Figure 9) should be constructed.

c. The proposed dock on the eastern side of the channel should continue to be permitted as proposed, assuming all criteria other than navigation are met. It does not appear that this dock, if built, would have an adverse effect on navigation within the proposed channel.

d. The proposed dock on the western side of the channel should continue to be permitted as proposed, assuming all criteria other than navigation are met, even though it is located on the outside of a bend. This recommendation is based on the pilots' evaluations, the fact that seven of the eight runs conducted were able to distance themselves from the ship docked at the proposed western facility, and the fact that many docks are built on the outside of bends without being a danger to navigation. Operational restrictions may need to be considered when outbound ships are to carry hazardous or volatile cargo past a ship docked at this facility. The restrictions might include no passage with vessel docked at the western facility, additional tug requirements, or daylight- only passage. The local office of the U.S. Coast Guard should be responsible for any such restrictions.

e. The Newton Creek Turning Basin should be widened as shown in Figure 21. This widening increases the turning basin size to 1,050 by 770 ft. Only one run in the proposed channel (Plate 13) would not turn in a basin this size. The run in Plate 13 required a north-south distance of 1,058 ft.

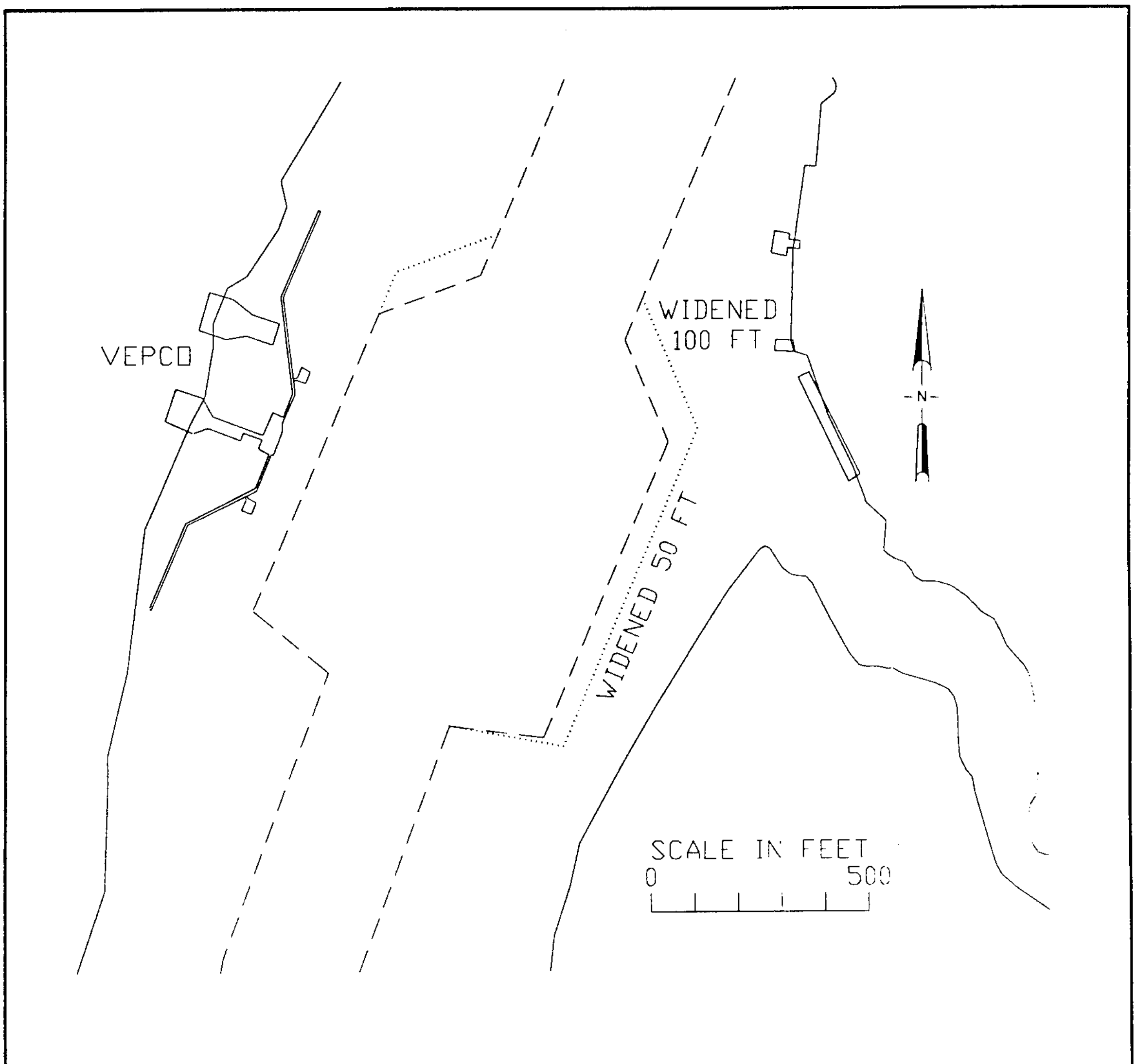


Figure 21. Recommended Newton Creek Turning Basin

f. The U.S. Coast Guard should consider installing center-line ranges on the channel through the I-64 bridge reach for the existing bridge. The ranges would provide immediate relief for some of the problems associated with the existing bridge. If a new span is considered (on the same alignment as the existing bridge), it should have a horizontal clearance of 135 ft. However, these recommendations for the I-64 bridge reach would not apply to a different alignment for the future bridge, nor to consideration of future ship traffic. Consideration of additional studies to evaluate bridge realignment and a change in ship traffic should be made during the planning and design of the future bridge.

References

Ankudinov, V. (1988a). "Hydrodynamic and mathematical models for ship maneuvering simulation of the bulk carrier *Asian Banner* in deep and shallow waters, and bank effects module in support of WES Sacramento Channel Study," Technical Report 87005.02-1, prepared for U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, by Tracor Hydronautics, Inc., Laurel, MD.

Ankudinov, V. (1988b). "Hydrodynamic and mathematical models for ship maneuvering simulations of 'LASH' barge carrier and two bulk carriers in support of the Pascagoula Harbor Study," Technical Report 87005.0623-1, Tracor Hydronautics, Inc., Laurel, MD.

Ankudinov, V. K. (1994). "Hydrodynamic and mathematical models for ship maneuvering simulations of the bulk carrier vessel *Asian Banner* in ballast condition in support of WES Elizabeth River Study (Gilmerton Bridges) navigation study," Technical Report 9292-014, prepared for U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, by Designers and Planners, Inc., Arlington, VA.

U.S. Coast and Geodetic Survey. (1958). "Tide tables, high and low water predictions, East Coast of North and South America, including Greenland," U.S. Department of Commerce, Washington, DC.

Webb, Dennis W., and Daggett, Larry L. "Ship navigation simulation study, Southern Branch of the Elizabeth River, Norfolk, Virginia" (in preparation), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

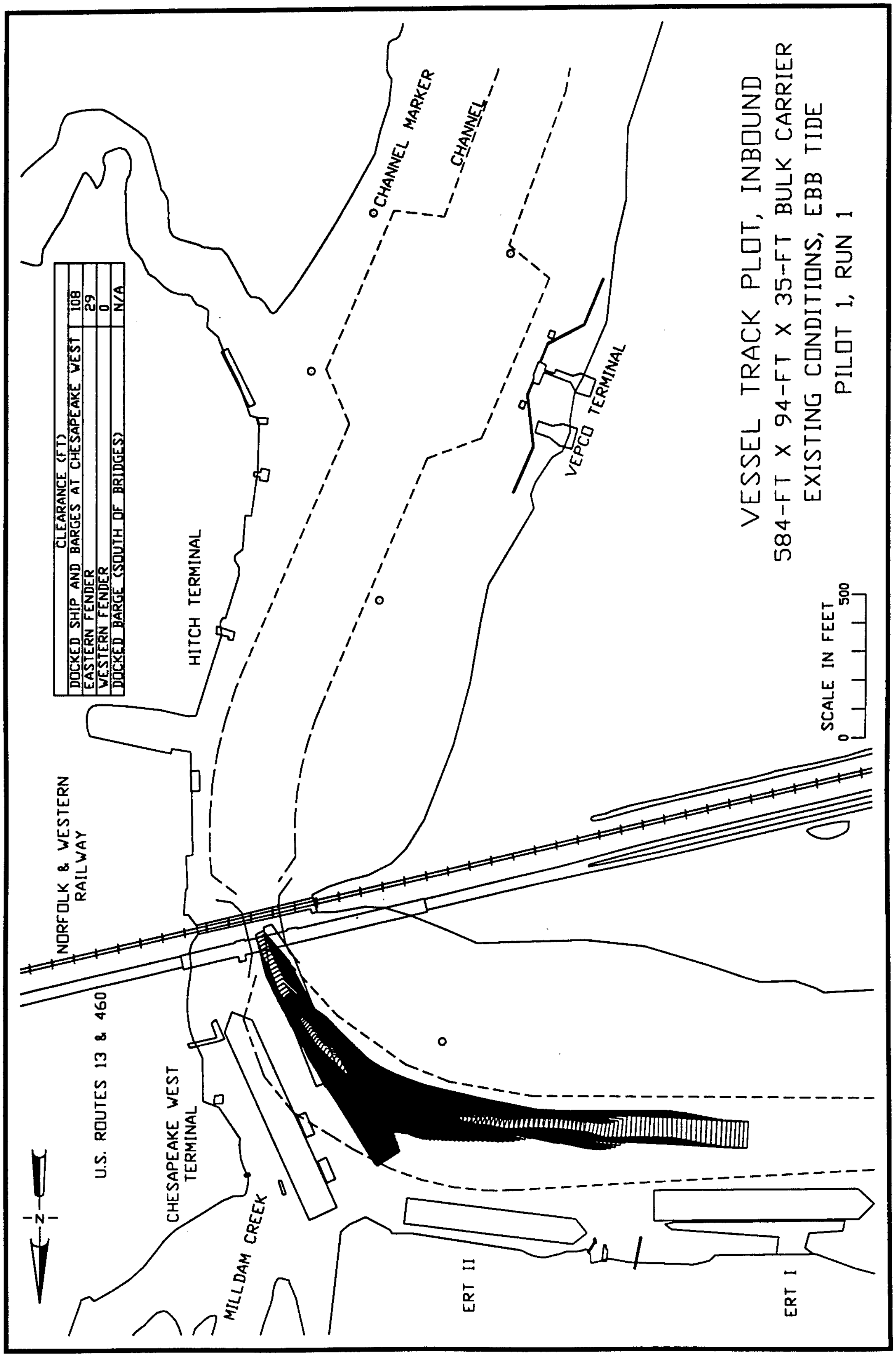

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
PILOT 1, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 108
EASTERN FENDER 29
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) N/A
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 1

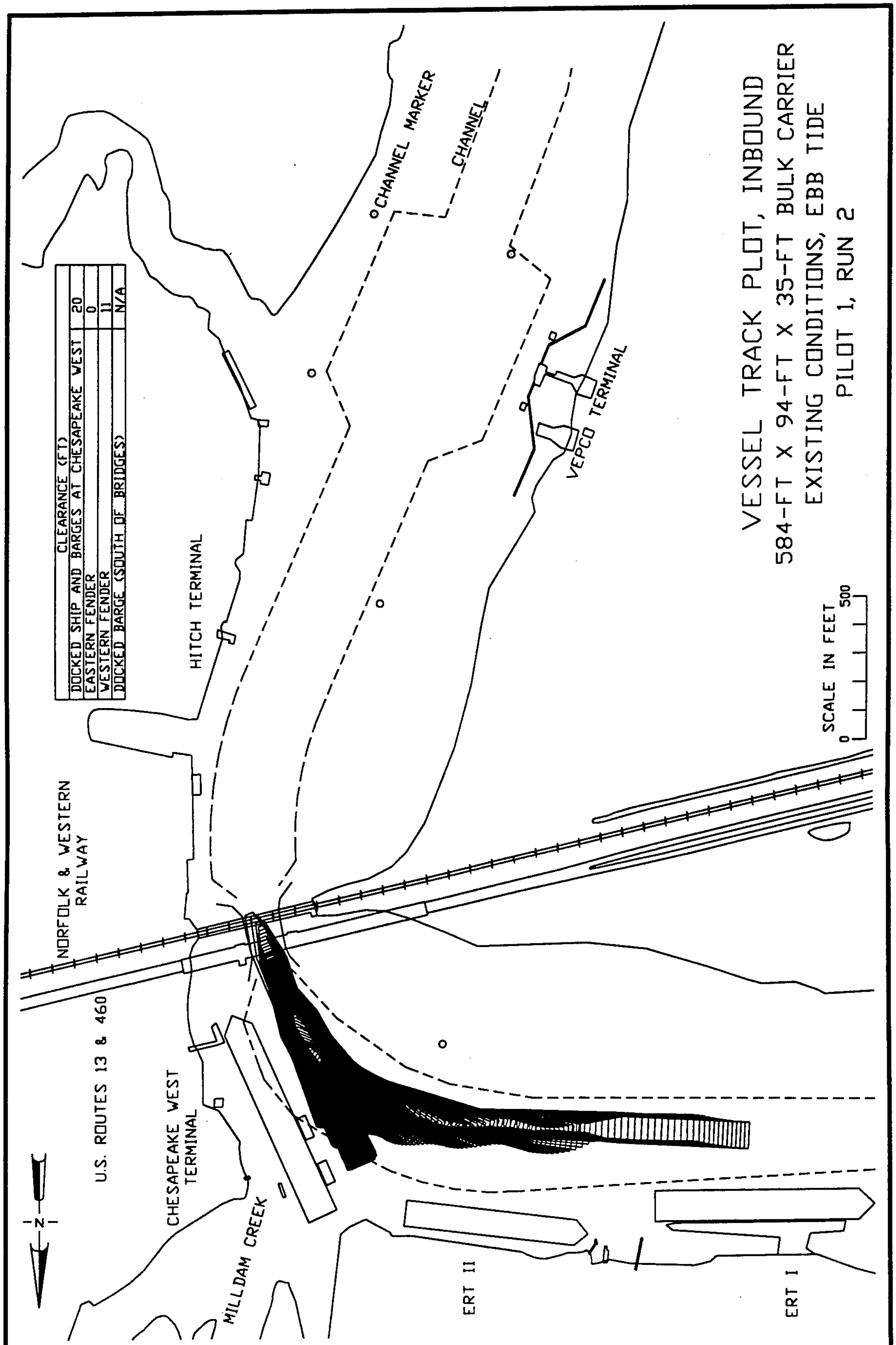

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
PILOT 1, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 20
EASTERN FENDER 0
WESTERN FENDER 11
DOCKED BARGE (SOUTH OF BRIDGES) N/A
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 2

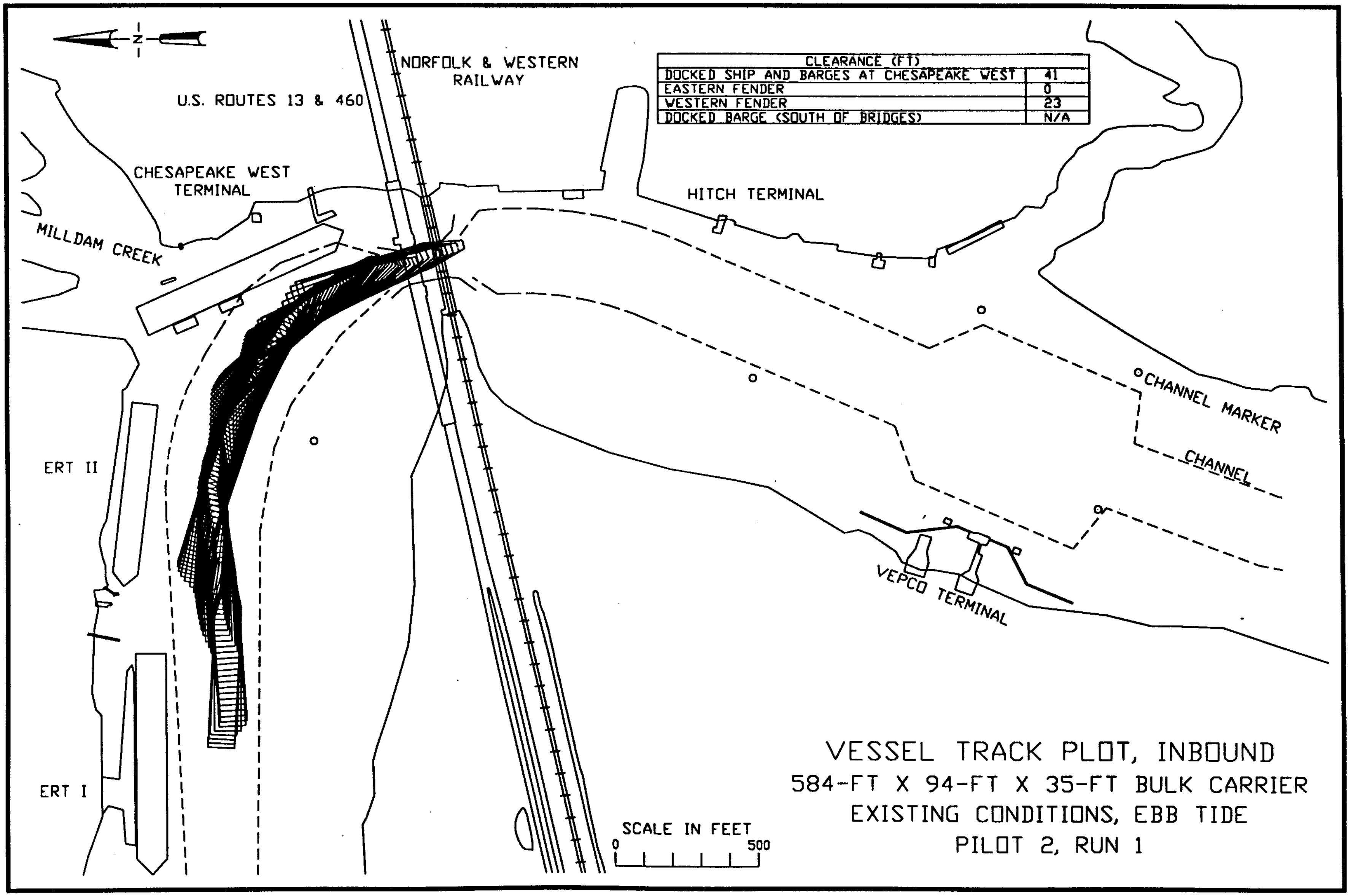
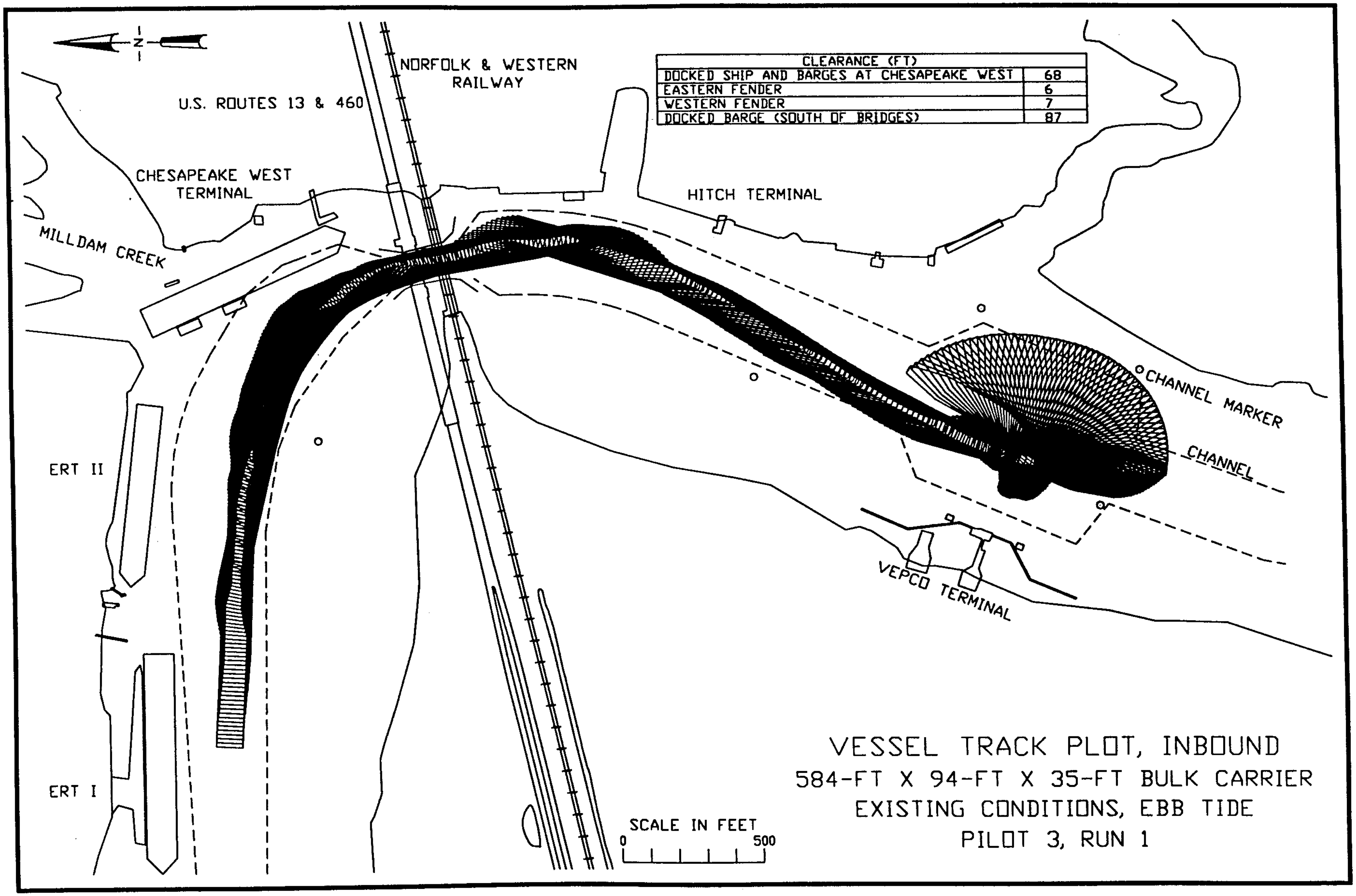
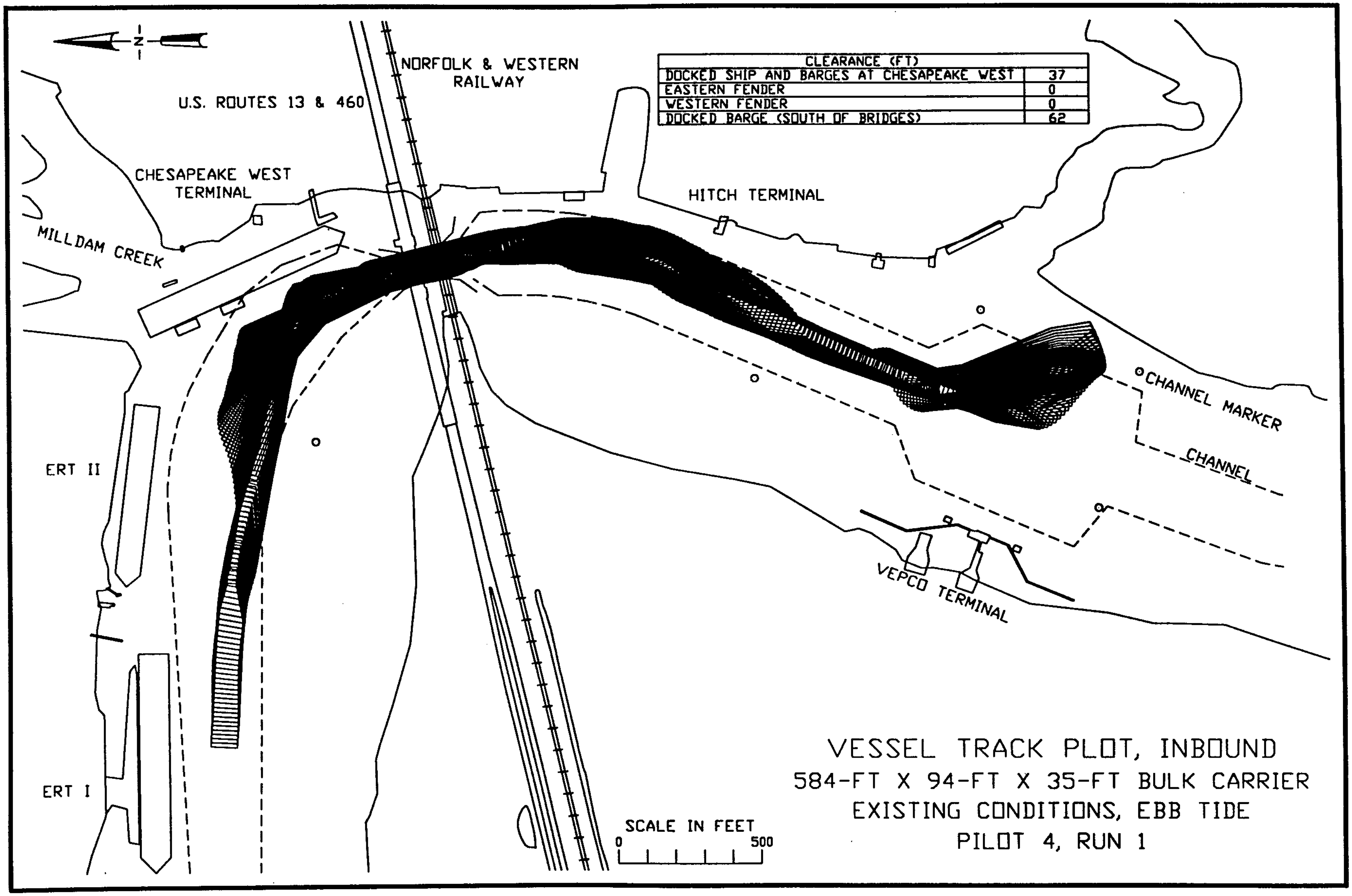

N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 41
EASTERN FENDER 0
WESTERN FENDER 23
DOCKED BARGE (SOUTH OF BRIDGES) N/A
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
PILOT 2, RUN 1

Plate 3



VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
PILOT 3, RUN 1

Plate 4



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	37
EASTERN FENDER	0
WESTERN FENDER	0
DOCKED BARGE (SOUTH OF BRIDGES)	62

Plate 5

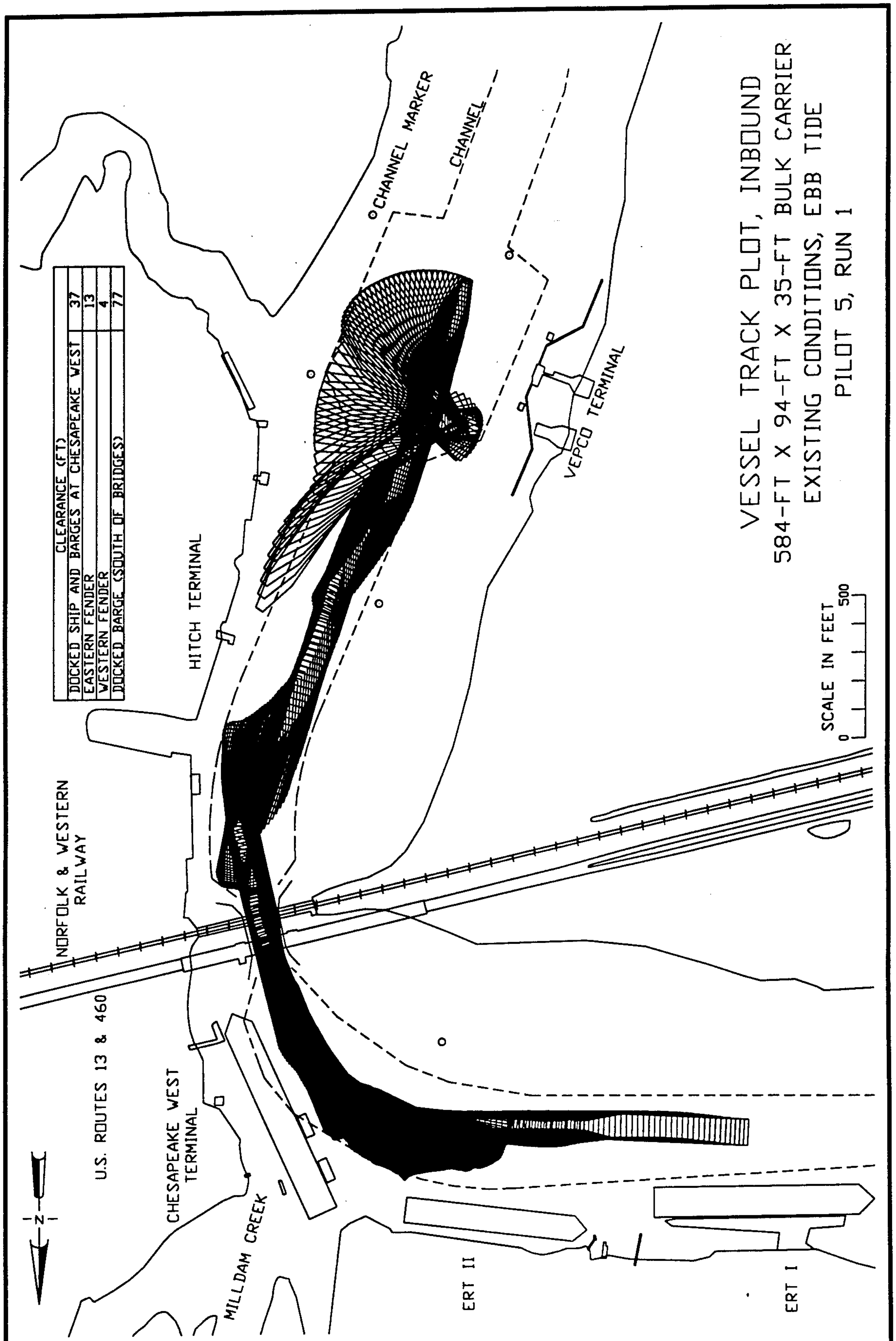
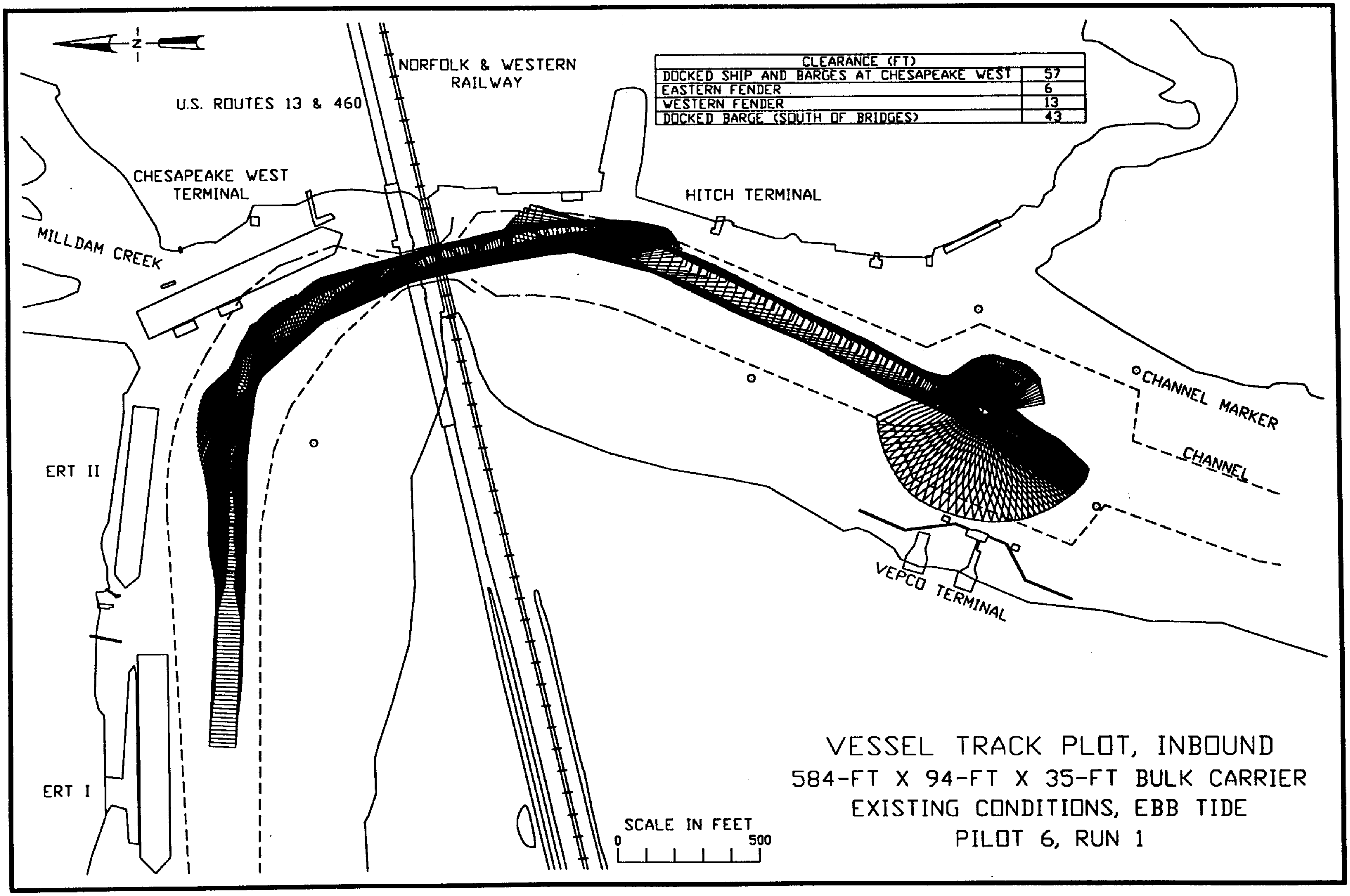
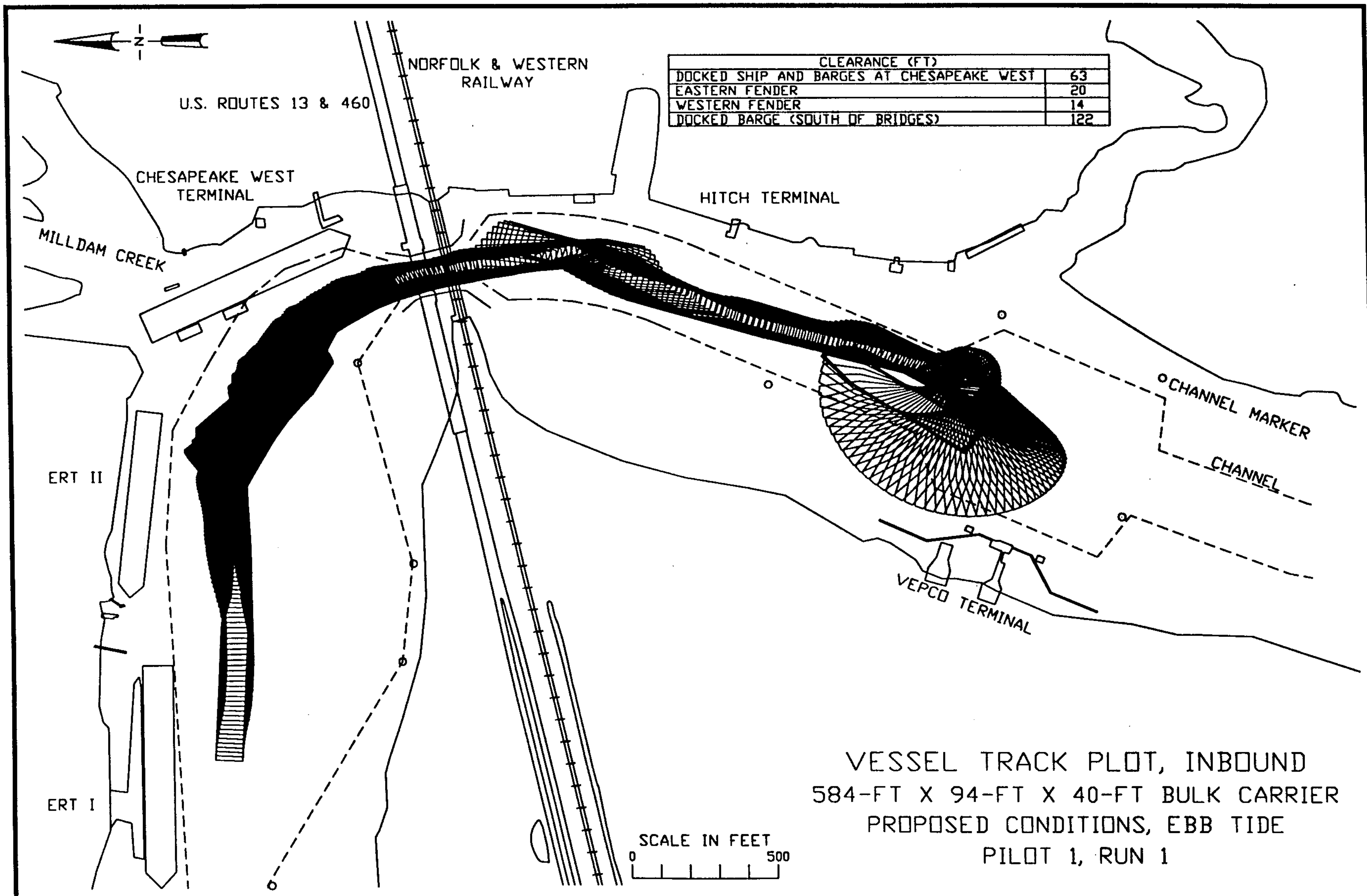

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 37
EASTERN FENDER 13
WESTERN FENDER 4
DOCKED BARGE (SOUTH OF BRIDGES) 77
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 6

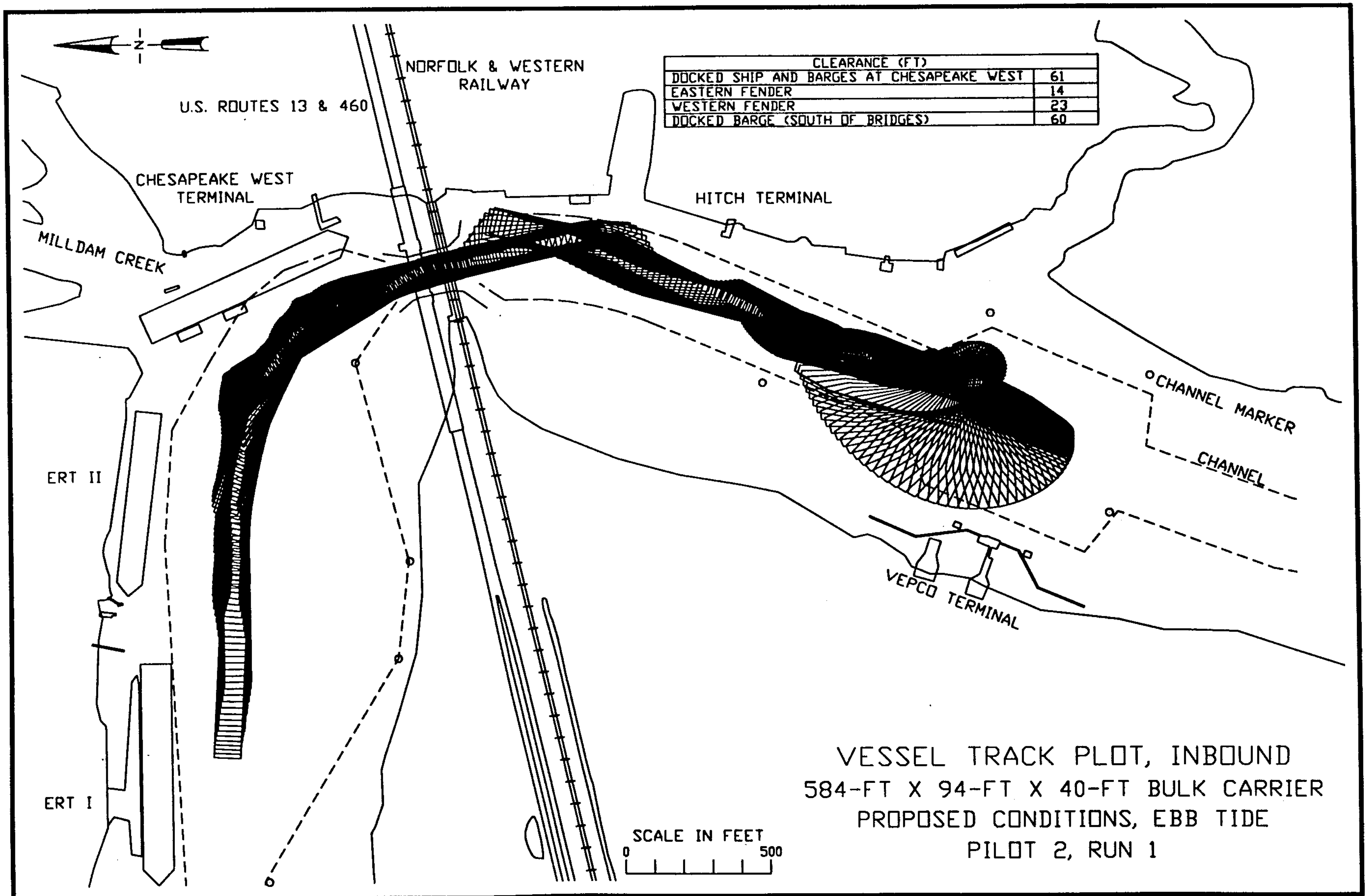


VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
PILOT 6, RUN 1



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	63
EASTERN FENDER	20
WESTERN FENDER	14
DOCKED BARGE (SOUTH OF BRIDGES)	122

Plate 8



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	61
EASTERN FENDER	14
WESTERN FENDER	23
DOCKED BARGE (SOUTH OF BRIDGES)	60

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 2, RUN 1

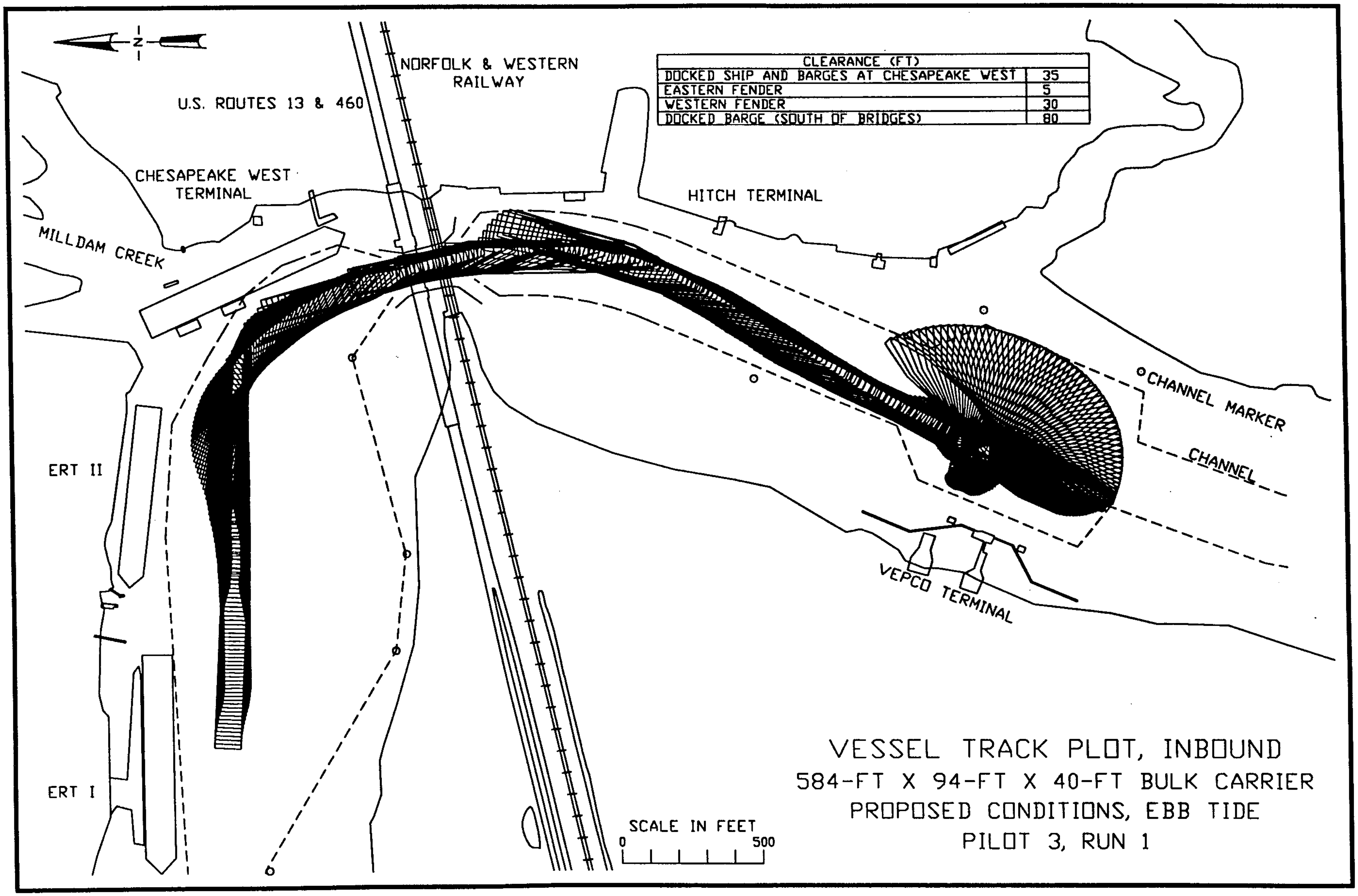

N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 35
EASTERN FENDER 5
WESTERN FENDER 30
DOCKED BARGE (SOUTH OF BRIDGES) 80
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 3, RUN 1

Plate 10

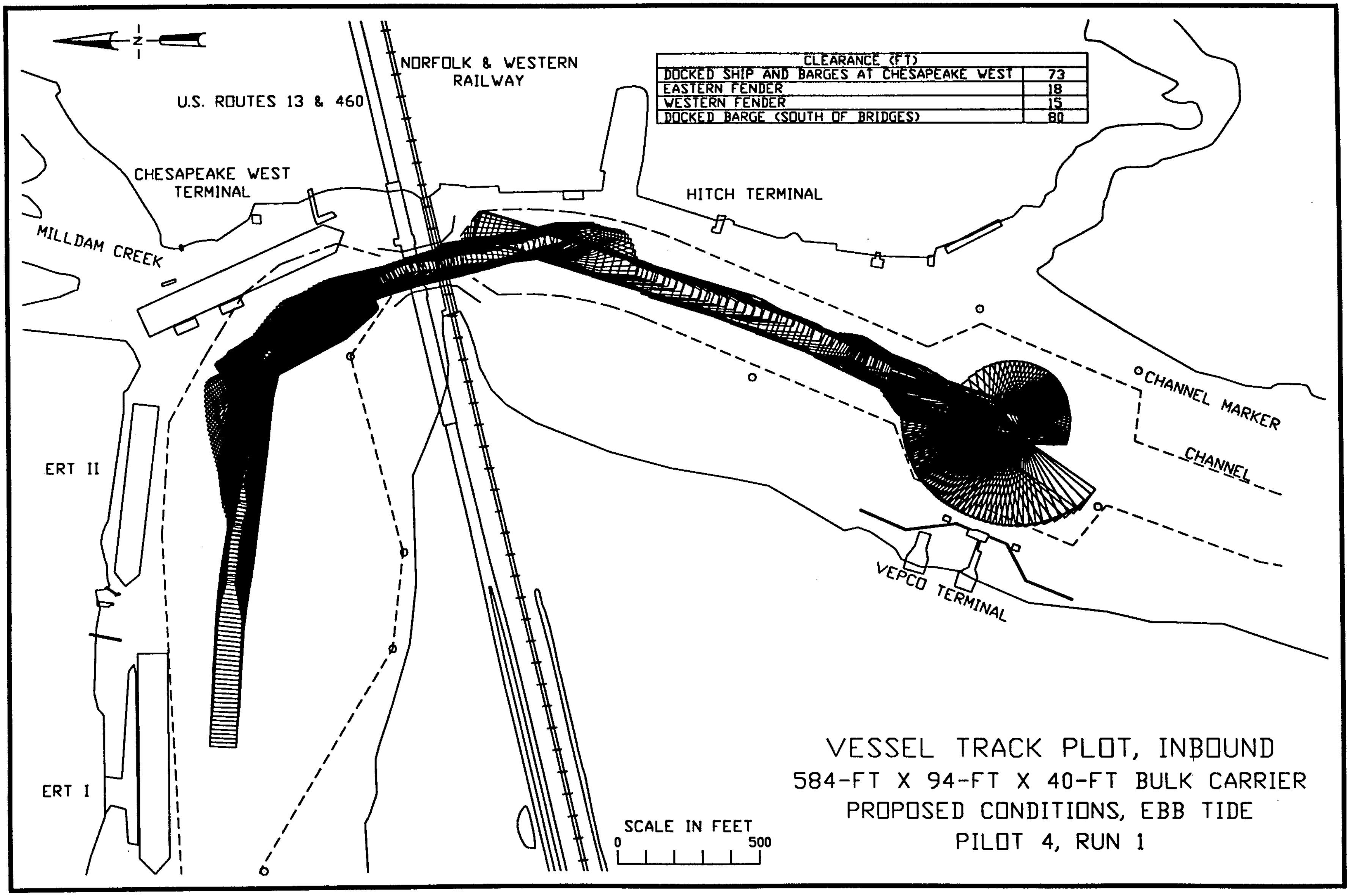

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 73
EASTERN FENDER 18
WESTERN FENDER 15
DOCKED BARGE (SOUTH OF BRIDGES) 80
N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
HITCH TERMINAL
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
ERT II
ERT I
SCALE IN FEET
0
500

Plate 11

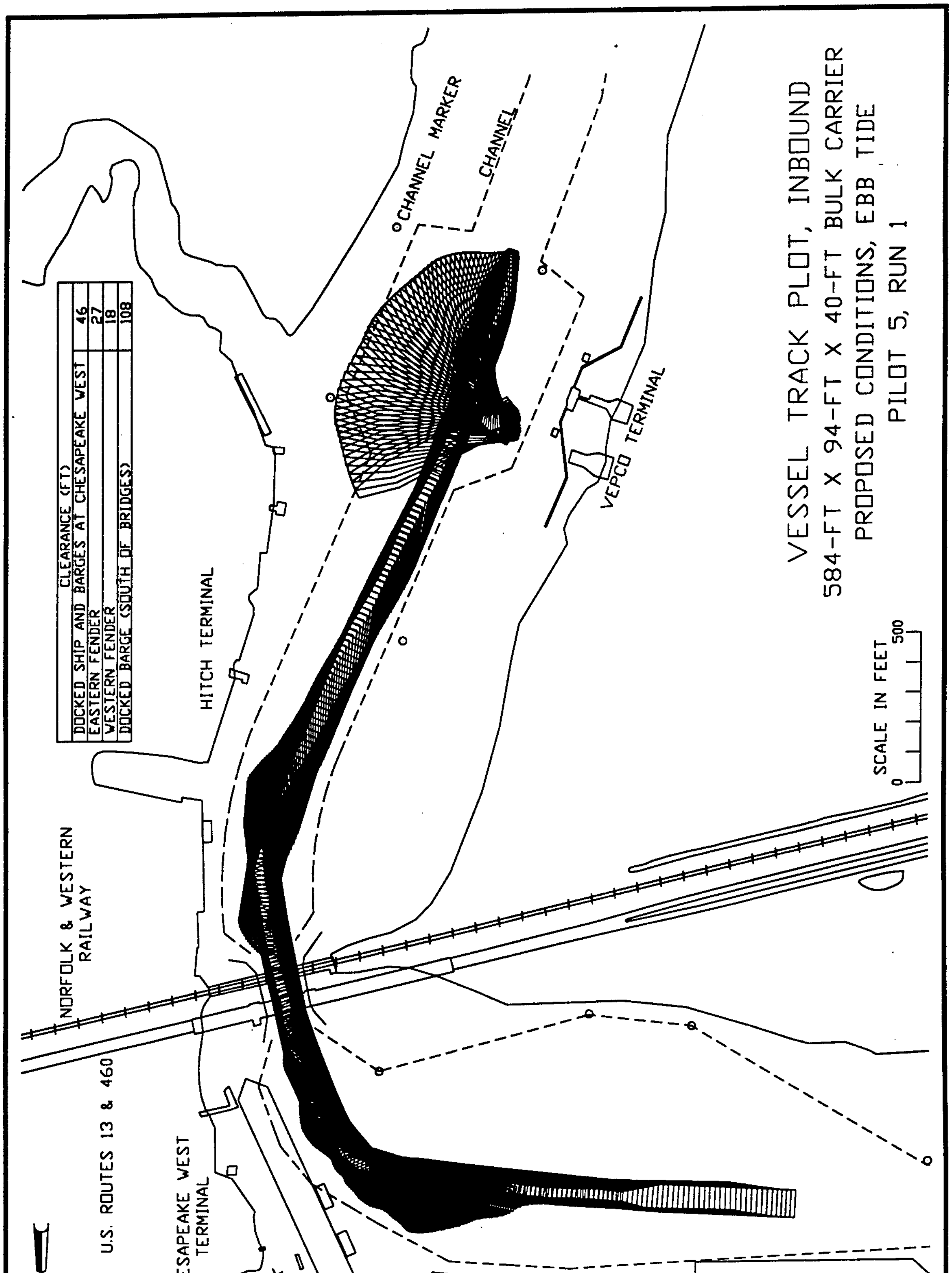
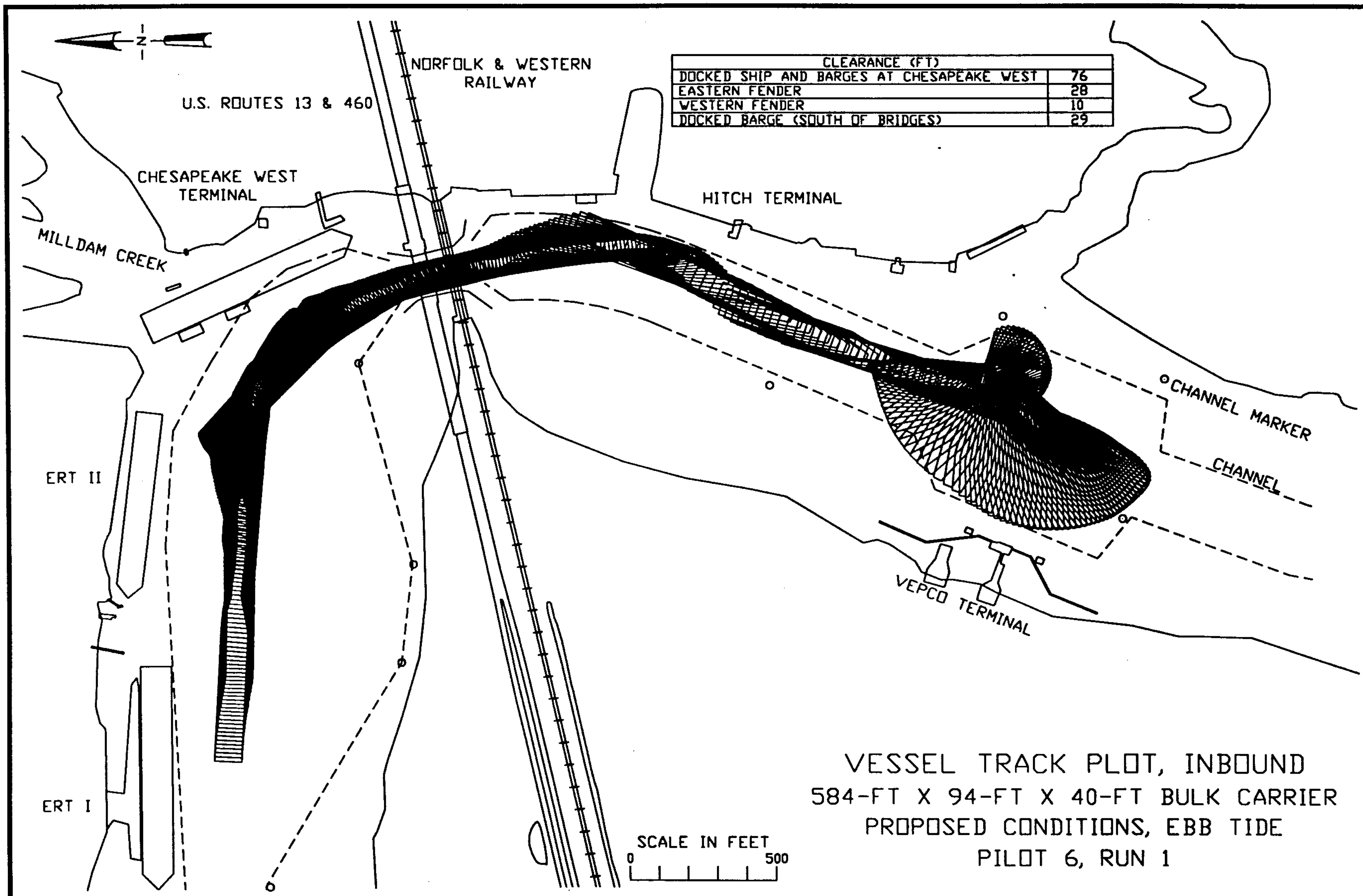

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 46
EASTERN FENDER 27
WESTERN FENDER 18
DOCKED BARGE (SOUTH OF BRIDGES) 108
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 12



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	76
EASTERN FENDER	28
WESTERN FENDER	10
DOCKED BARGE (SOUTH OF BRIDGES)	29

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 6, RUN 1

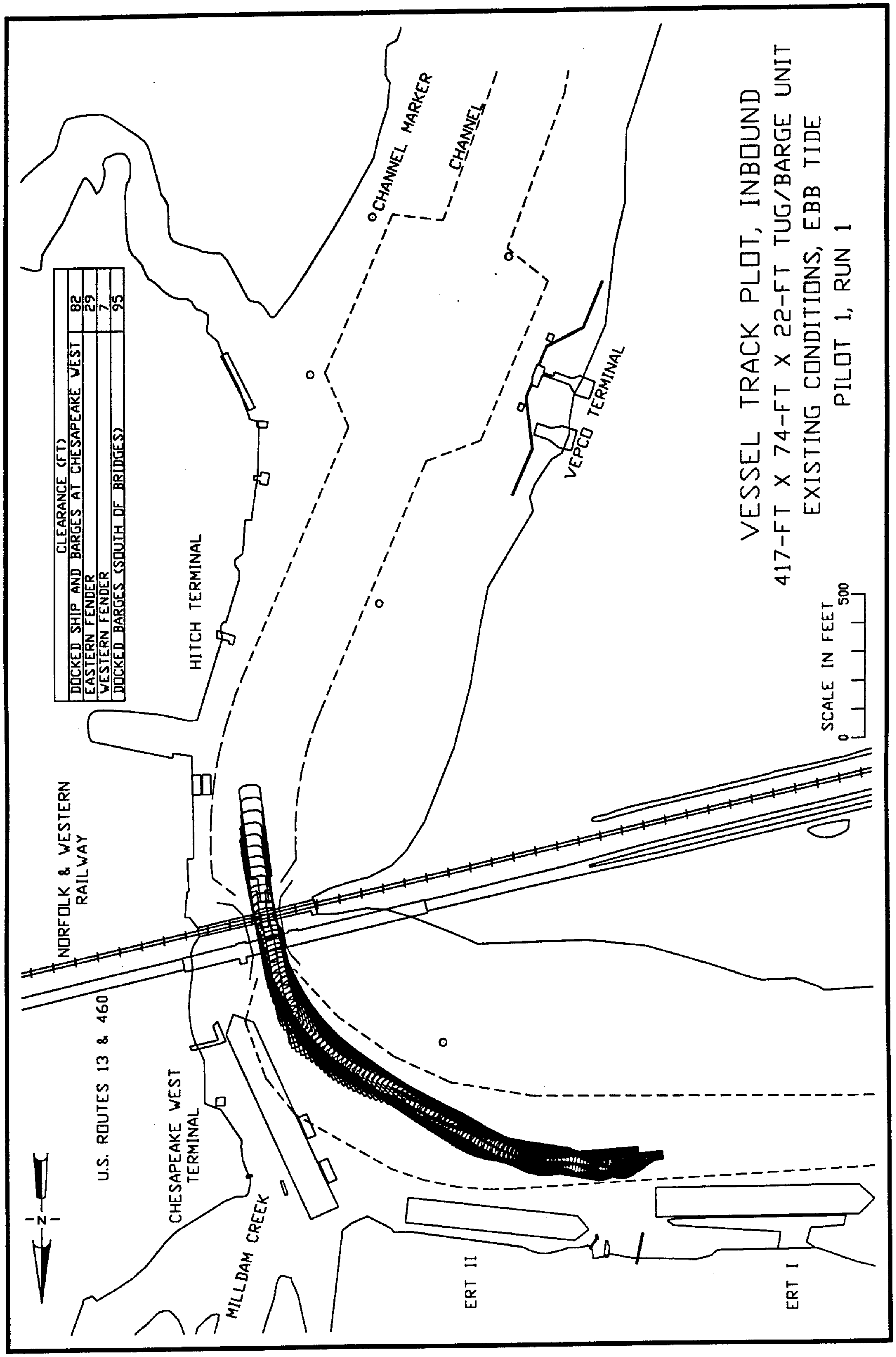
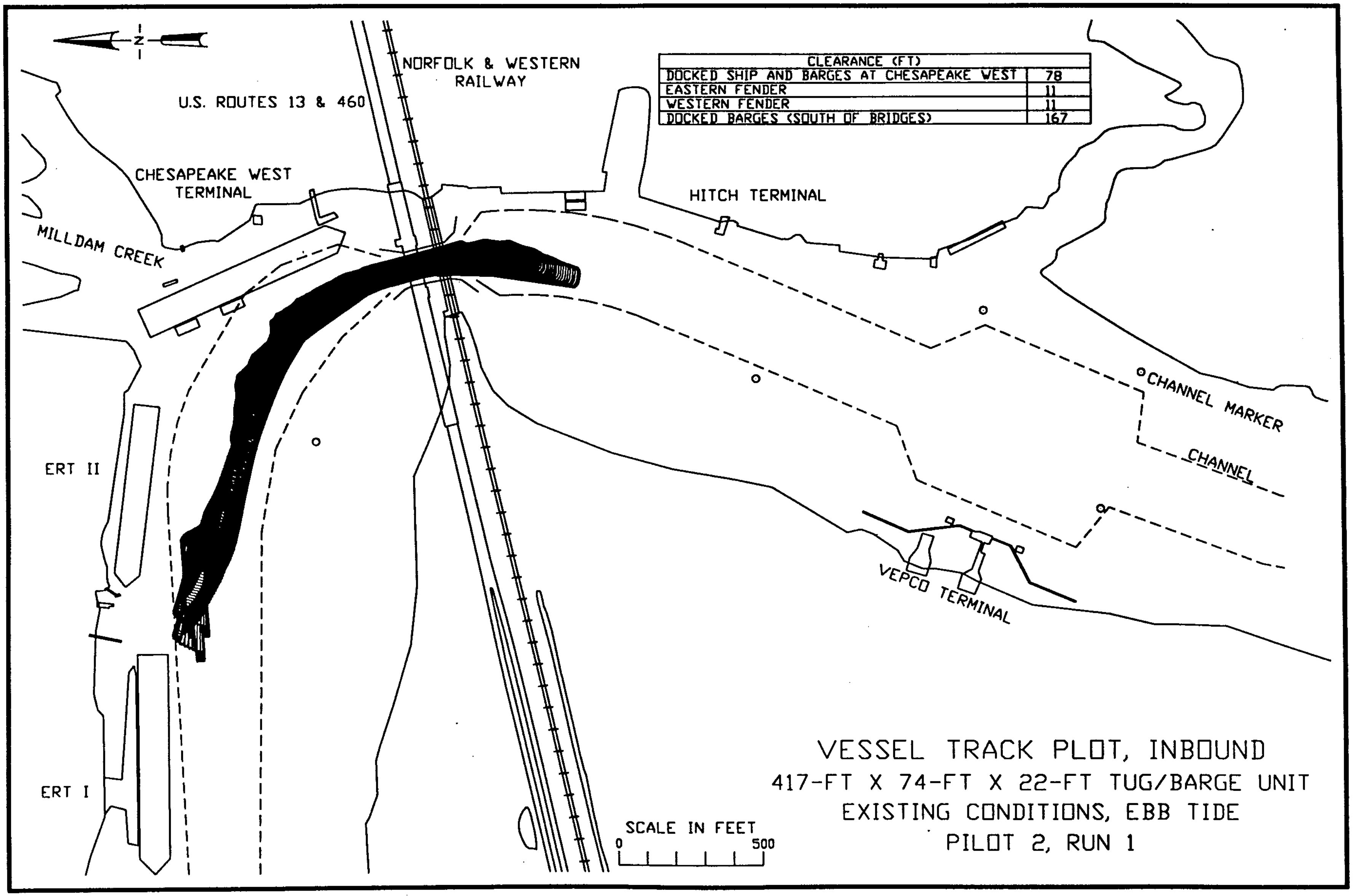
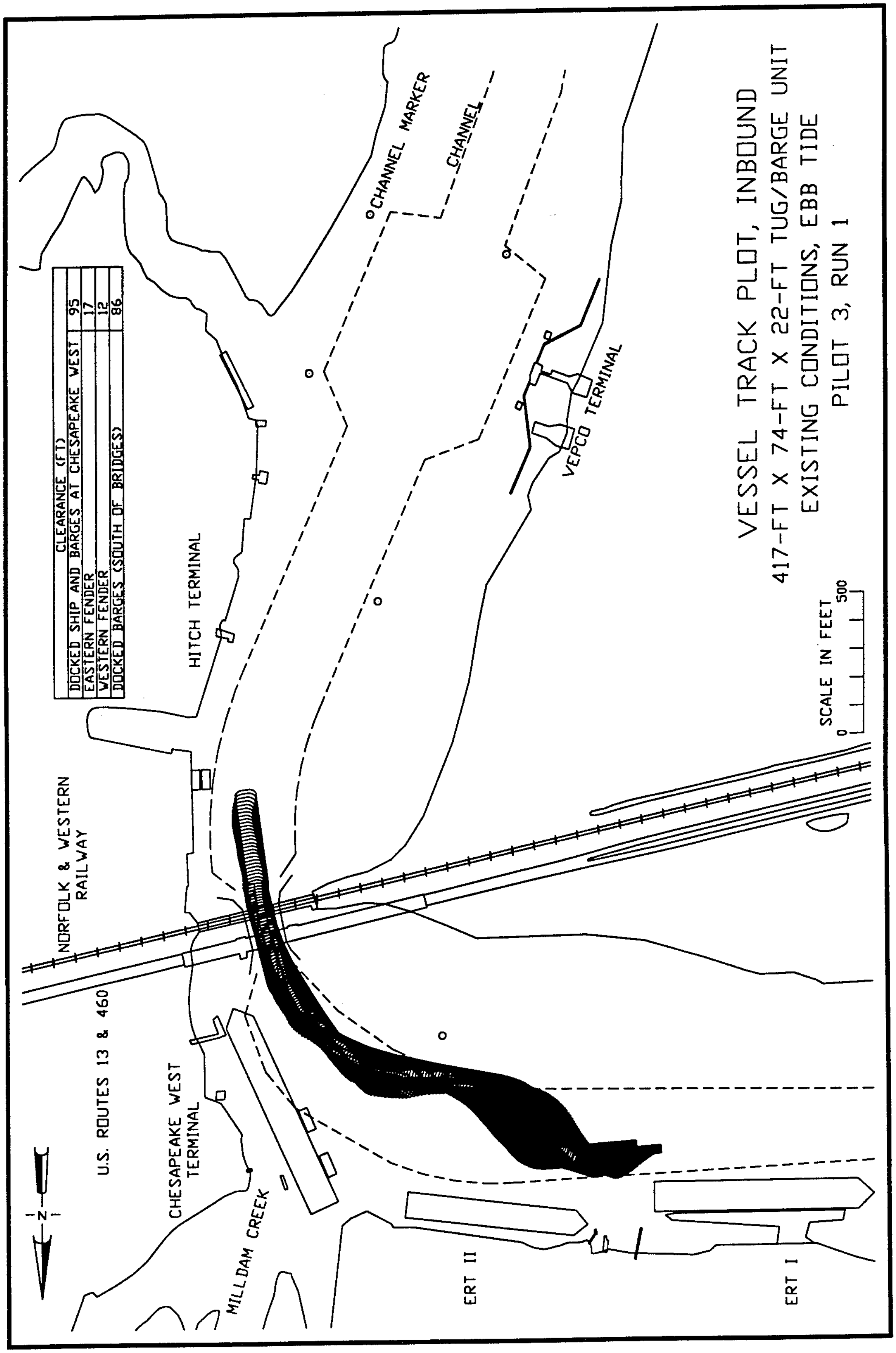

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
PILOT 1, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 82
EASTERN FENDER 29
WESTERN FENDER 7
DOCKED BARGES (SOUTH OF BRIDGES) 95
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 14

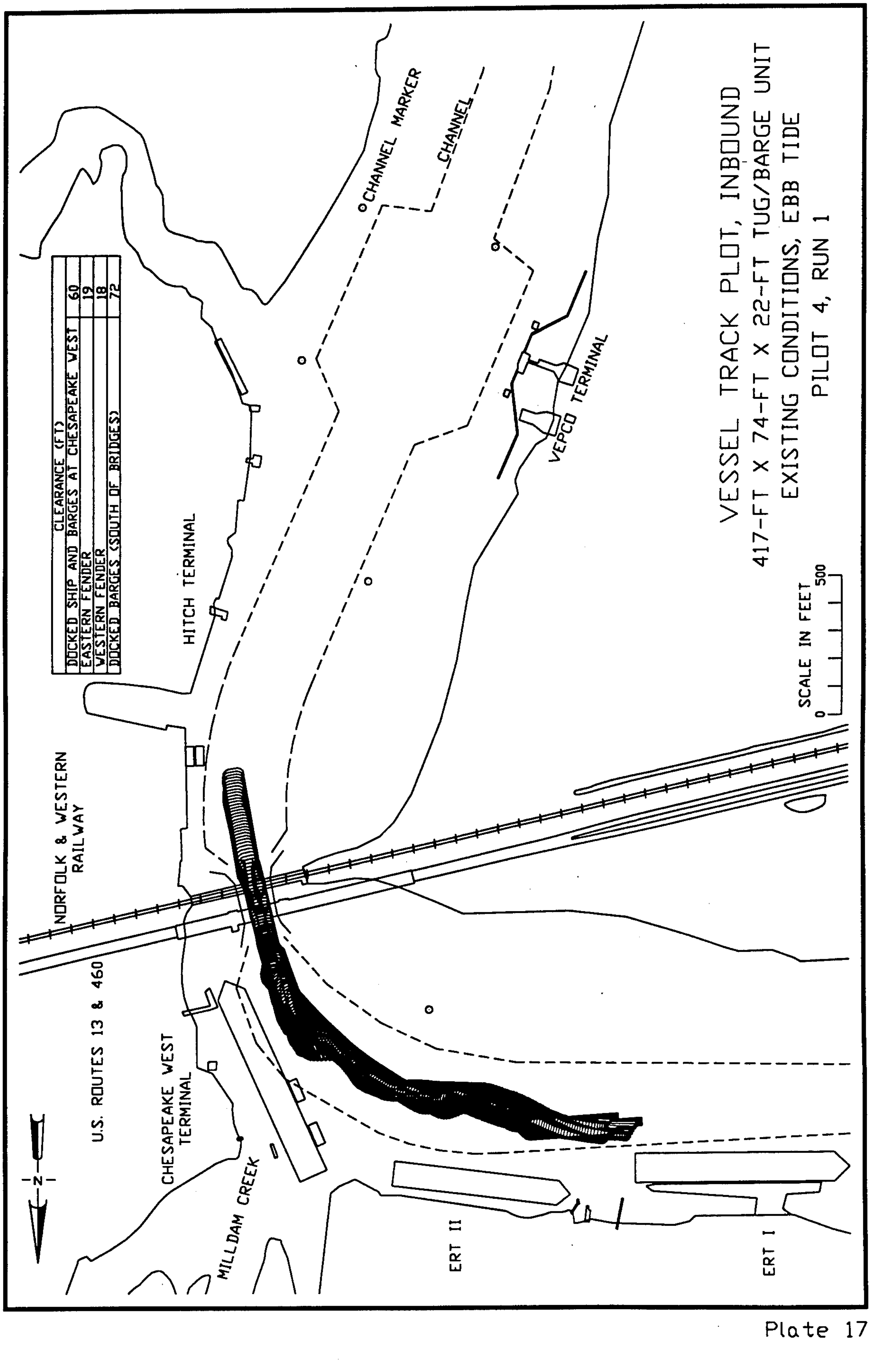


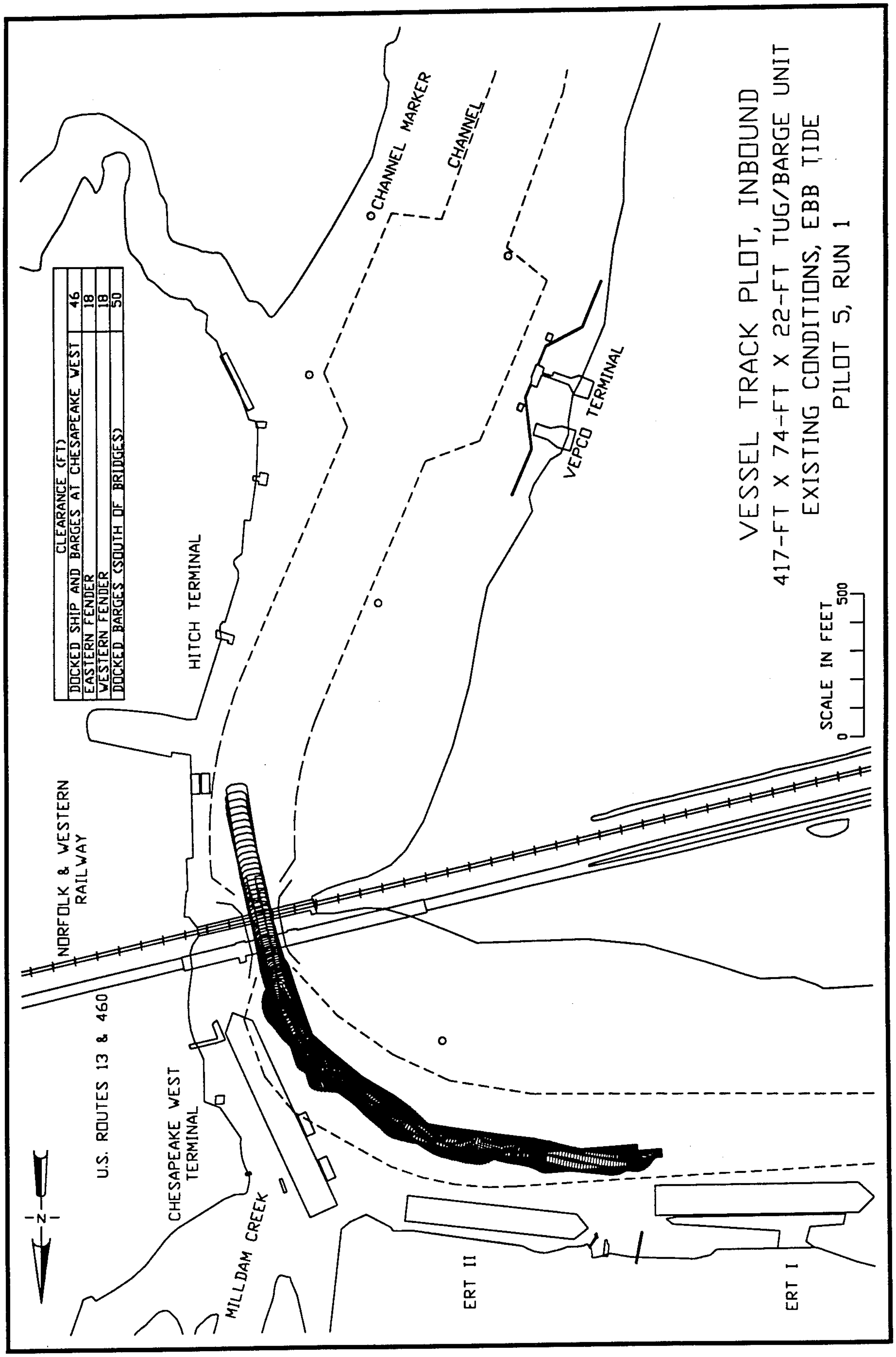
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
PILOT 2, RUN 1

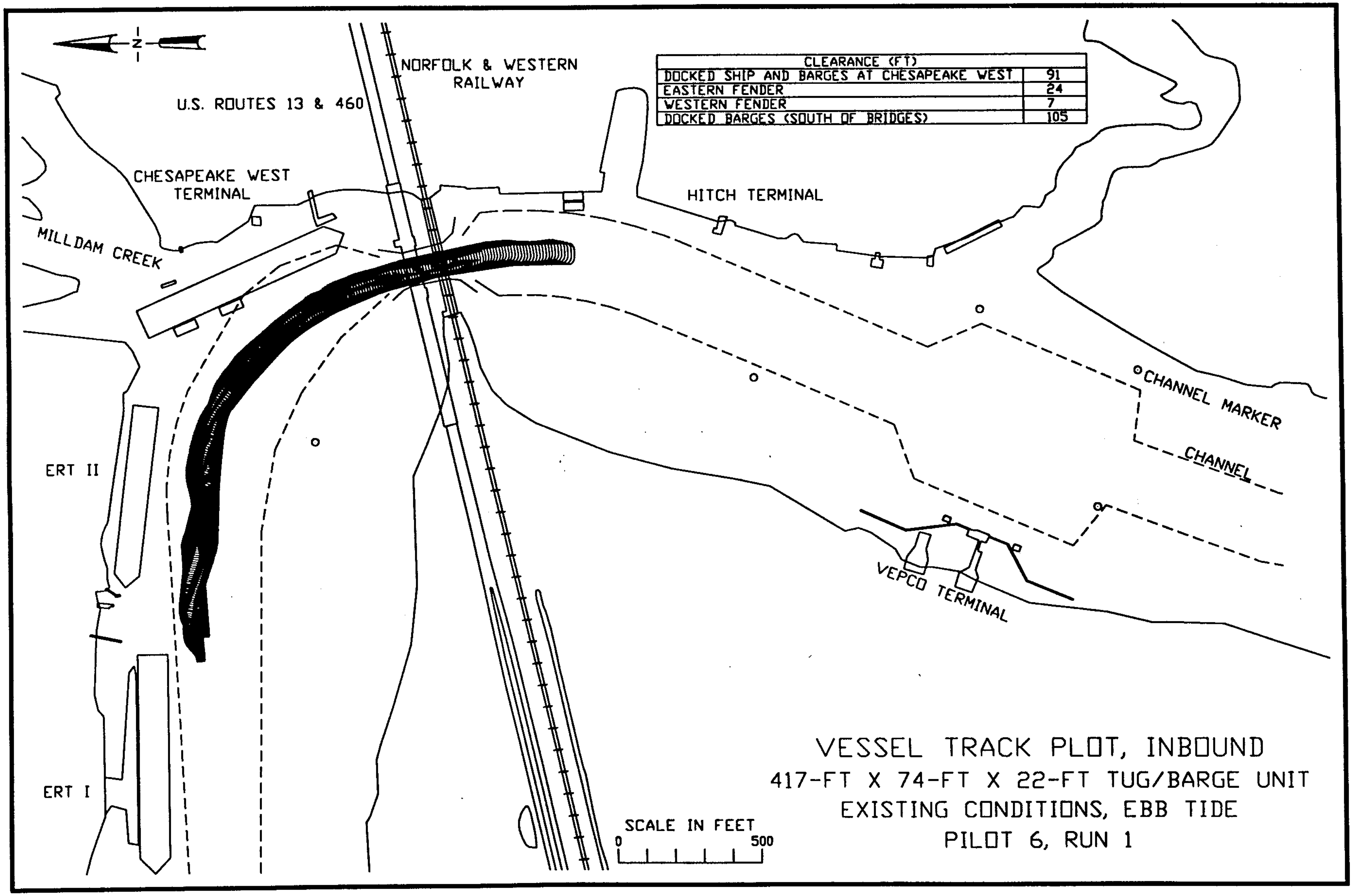


VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
PILOT 3, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 95
EASTERN FENDER 17
WESTERN FENDER 12
DOCKED BARGES (SOUTH OF BRIDGES) 86
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 16


VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 60
EASTERN FENDER 19
WESTERN FENDER 18
DOCKED BARGES (SOUTH OF BRIDGES) 72
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500


VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 46
EASTERN FENDER 18
WESTERN FENDER 18
DOCKED BARGES (SOUTH OF BRIDGES) 50
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N
Plate 18



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	91
EASTERN FENDER	24
WESTERN FENDER	7
DOCKED BARGES (SOUTH OF BRIDGES)	105

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
PILOT 6, RUN 1

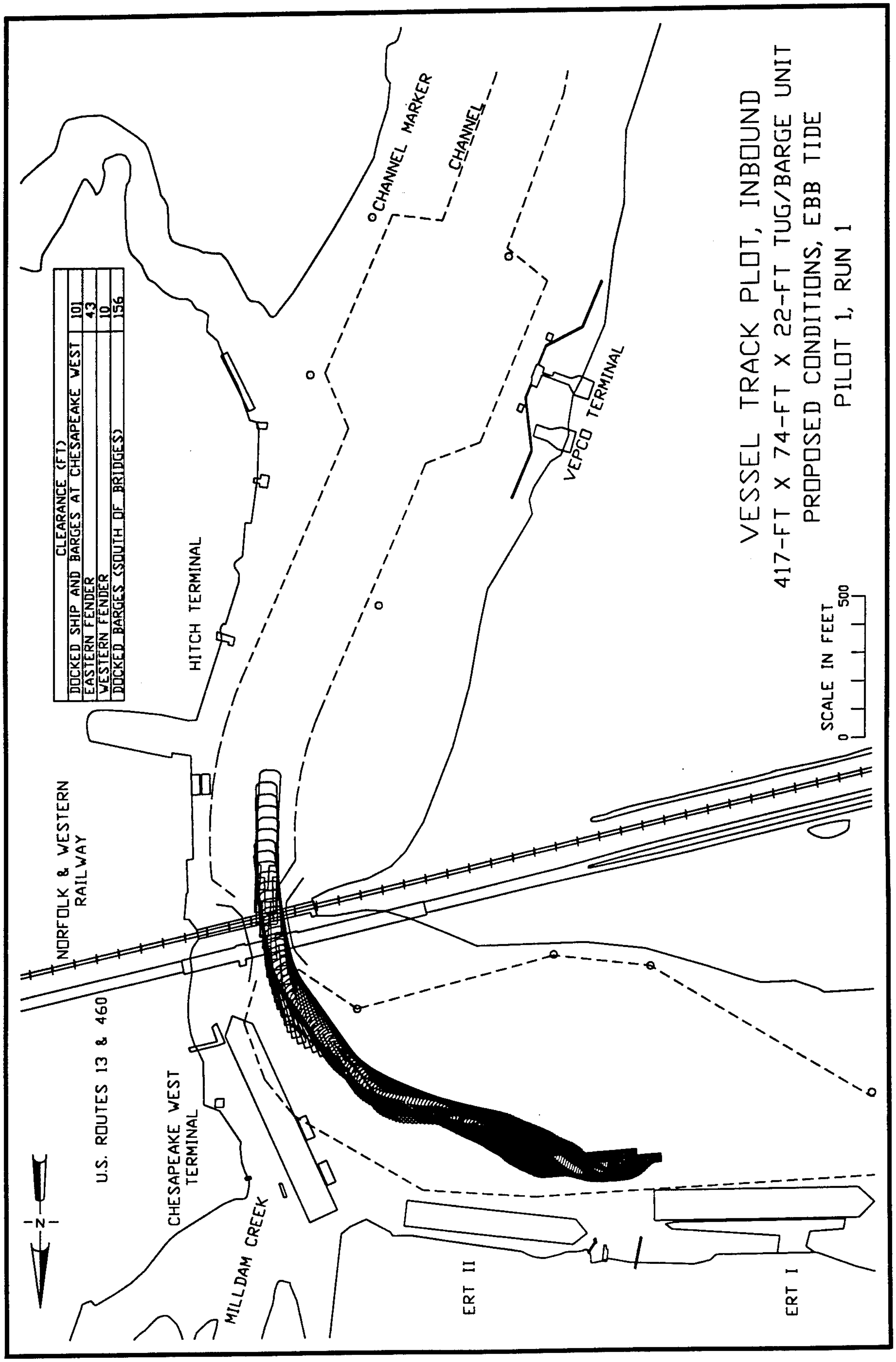
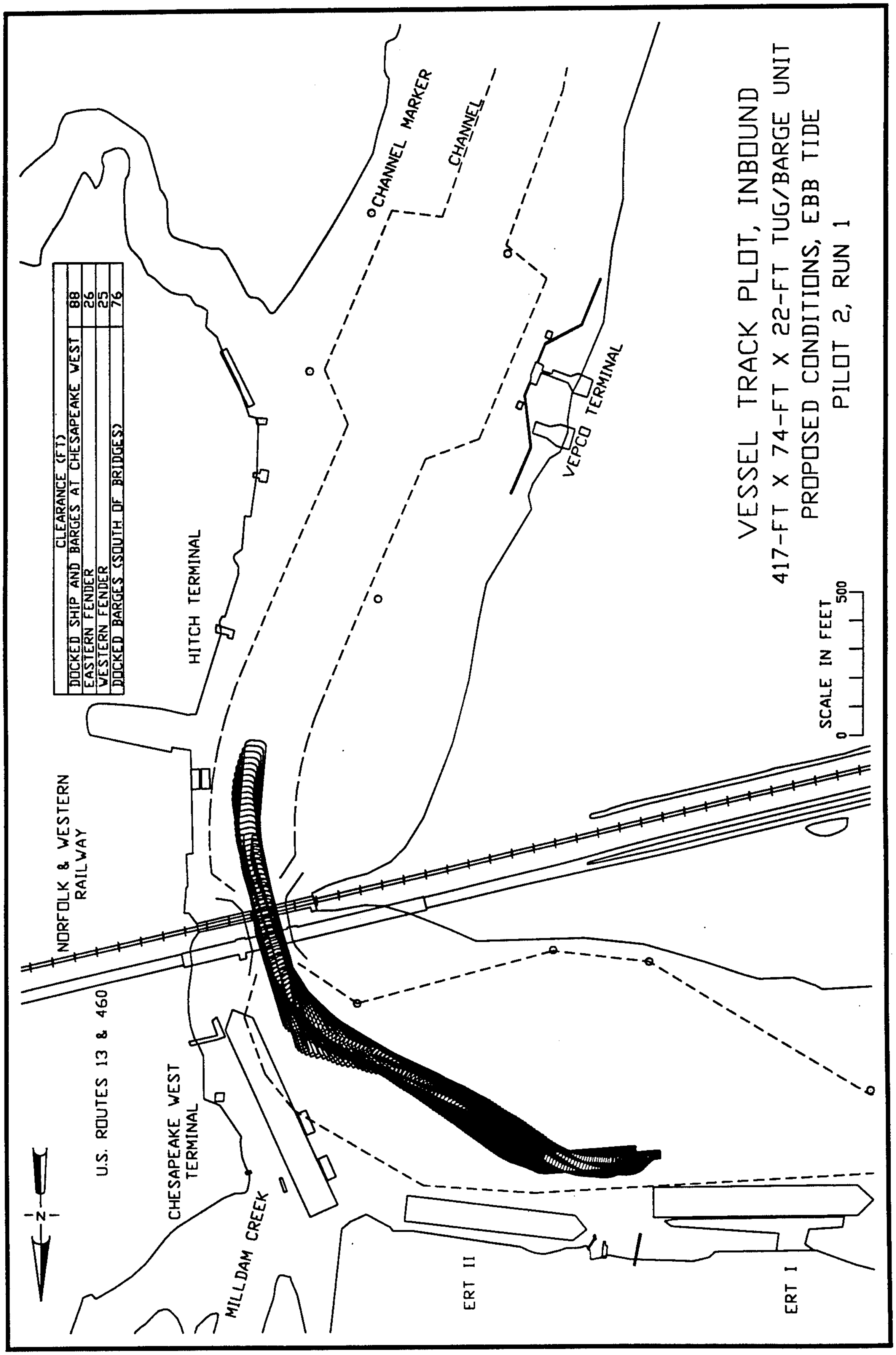
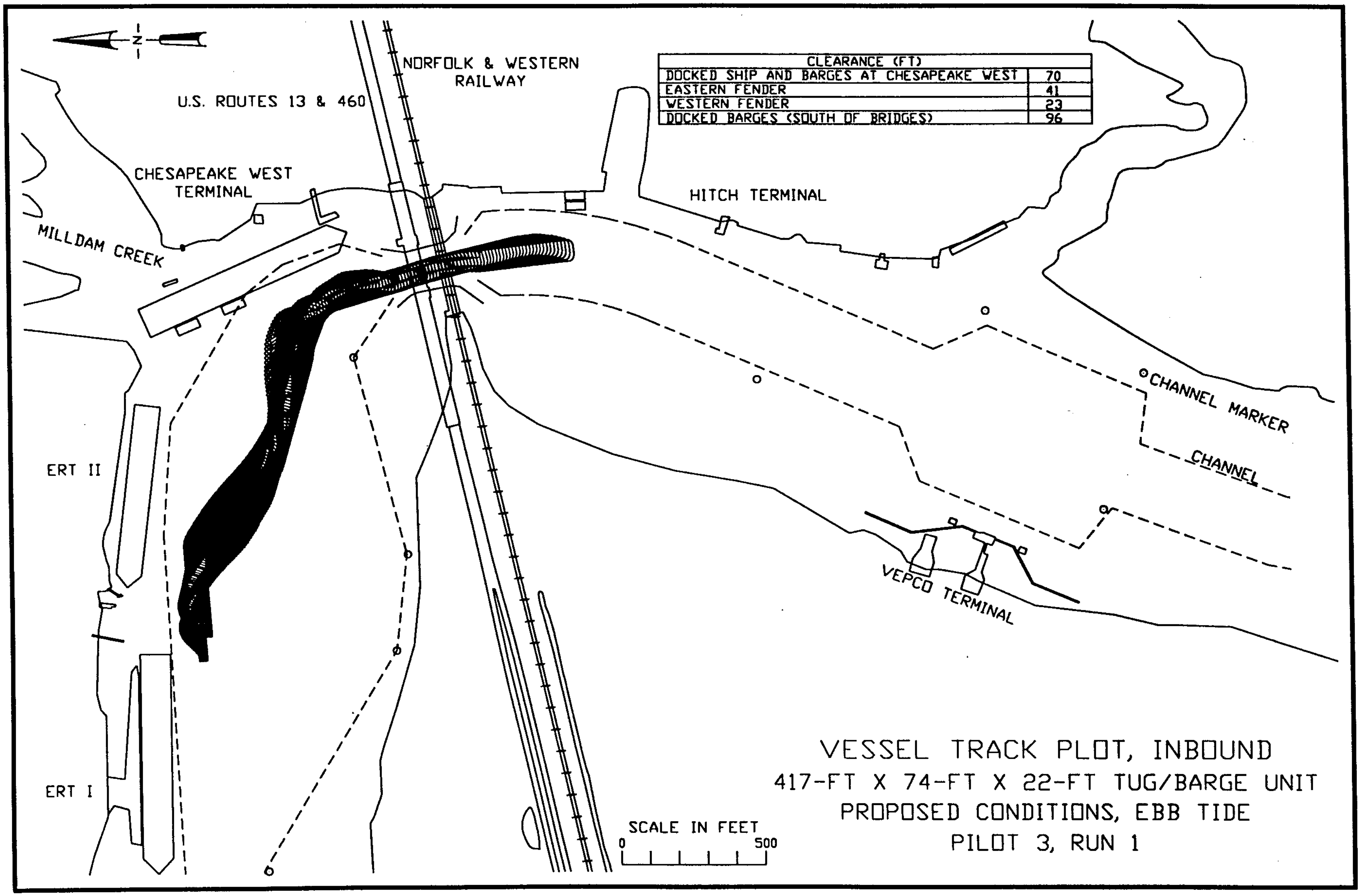

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
PILOT 1, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 101
EASTERN FENDER 43
WESTERN FENDER 10
DOCKED BARGES (SOUTH OF BRIDGES) 156
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 20



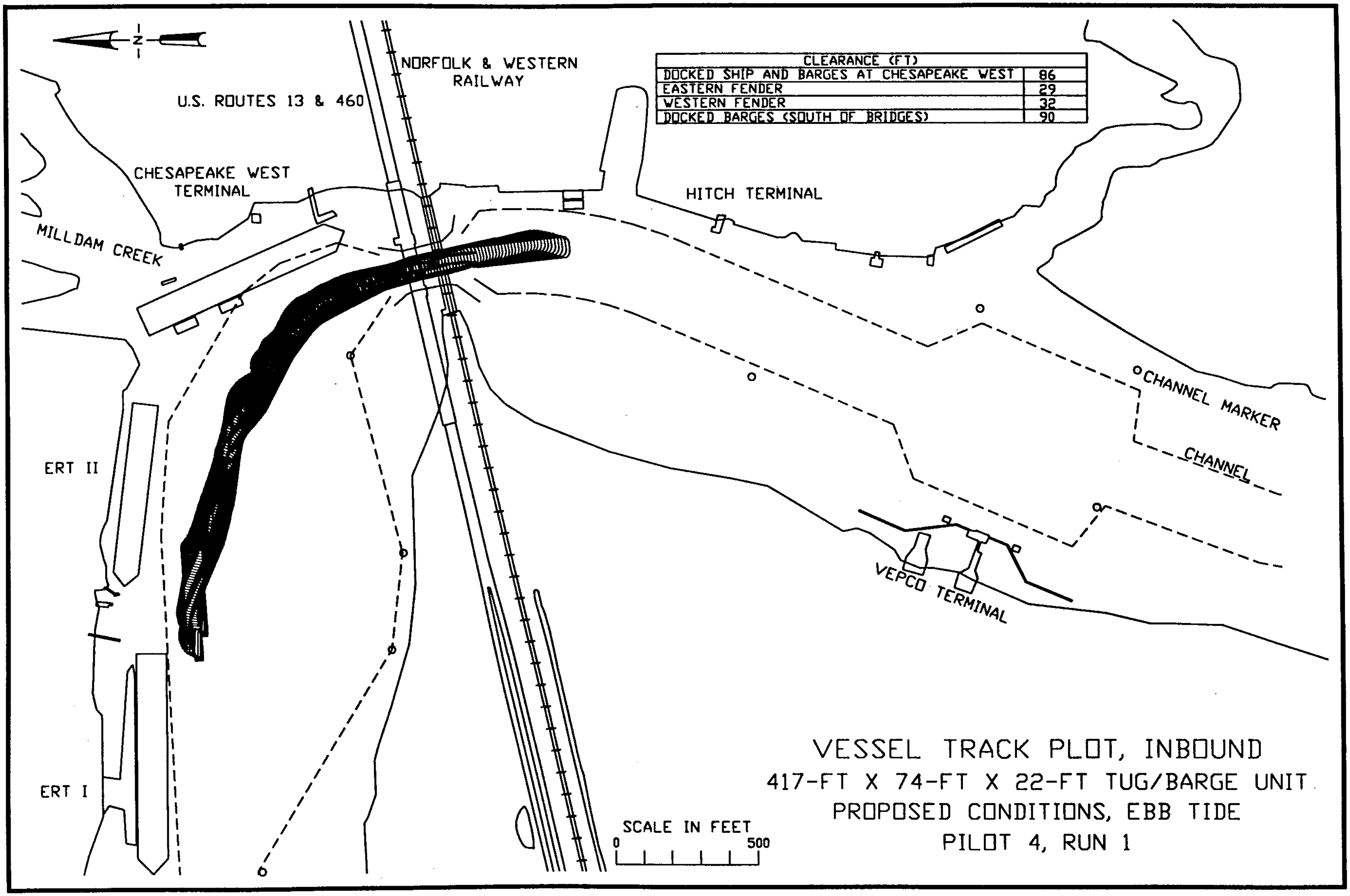
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
PILOT 2, RUN 1

Plate 21



VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
PILOT 3, RUN 1

Plate 22



N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 86
EASTERN FENDER 29
WESTERN FENDER 32
DOCKED BARGES (SOUTH OF BRIDGES) 90
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
PILOT 4, RUN 1

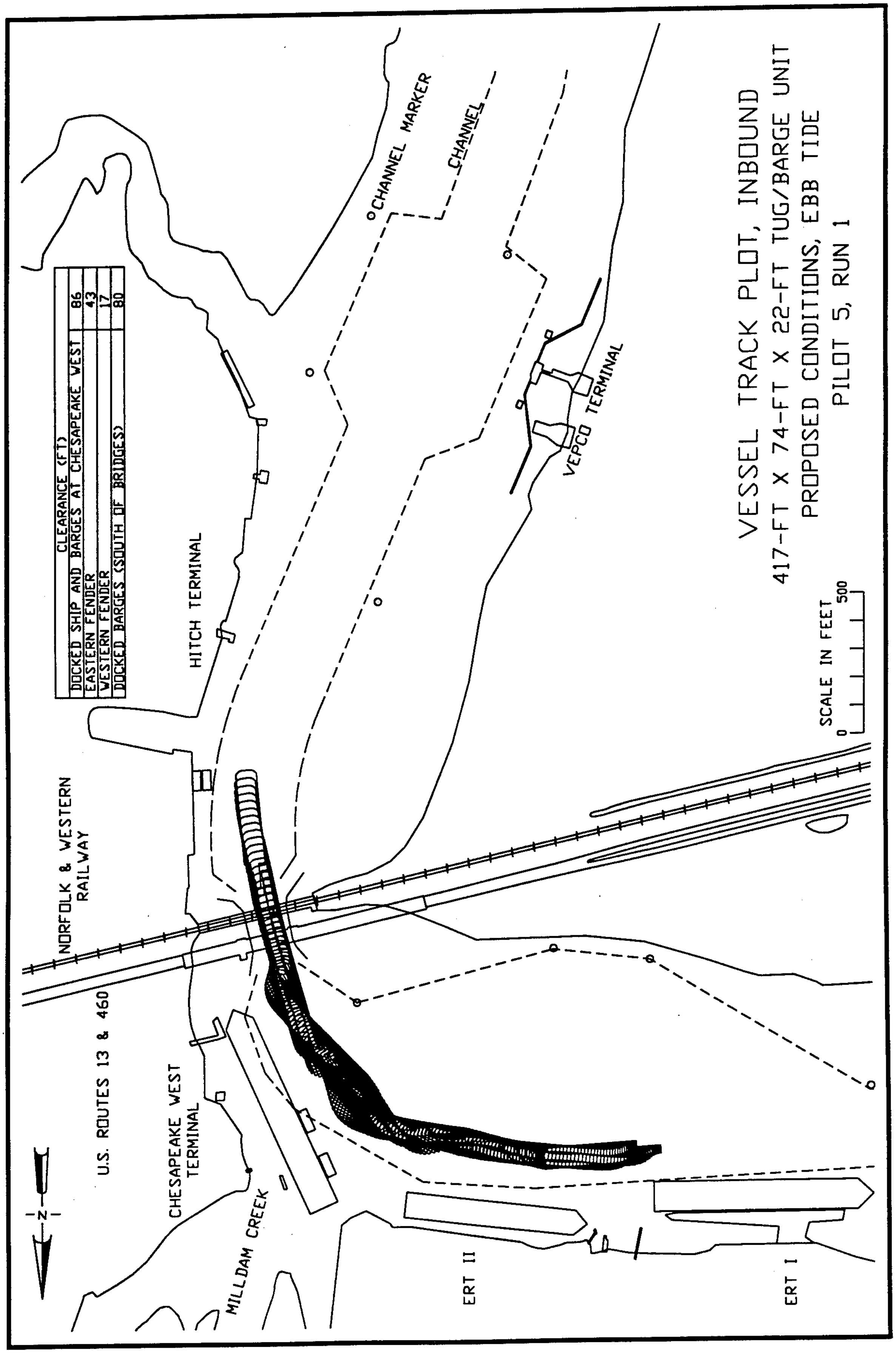

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 86
EASTERN FENDER 43
WESTERN FENDER 17
DOCKED BARGES (SOUTH OF BRIDGES) 80
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 24

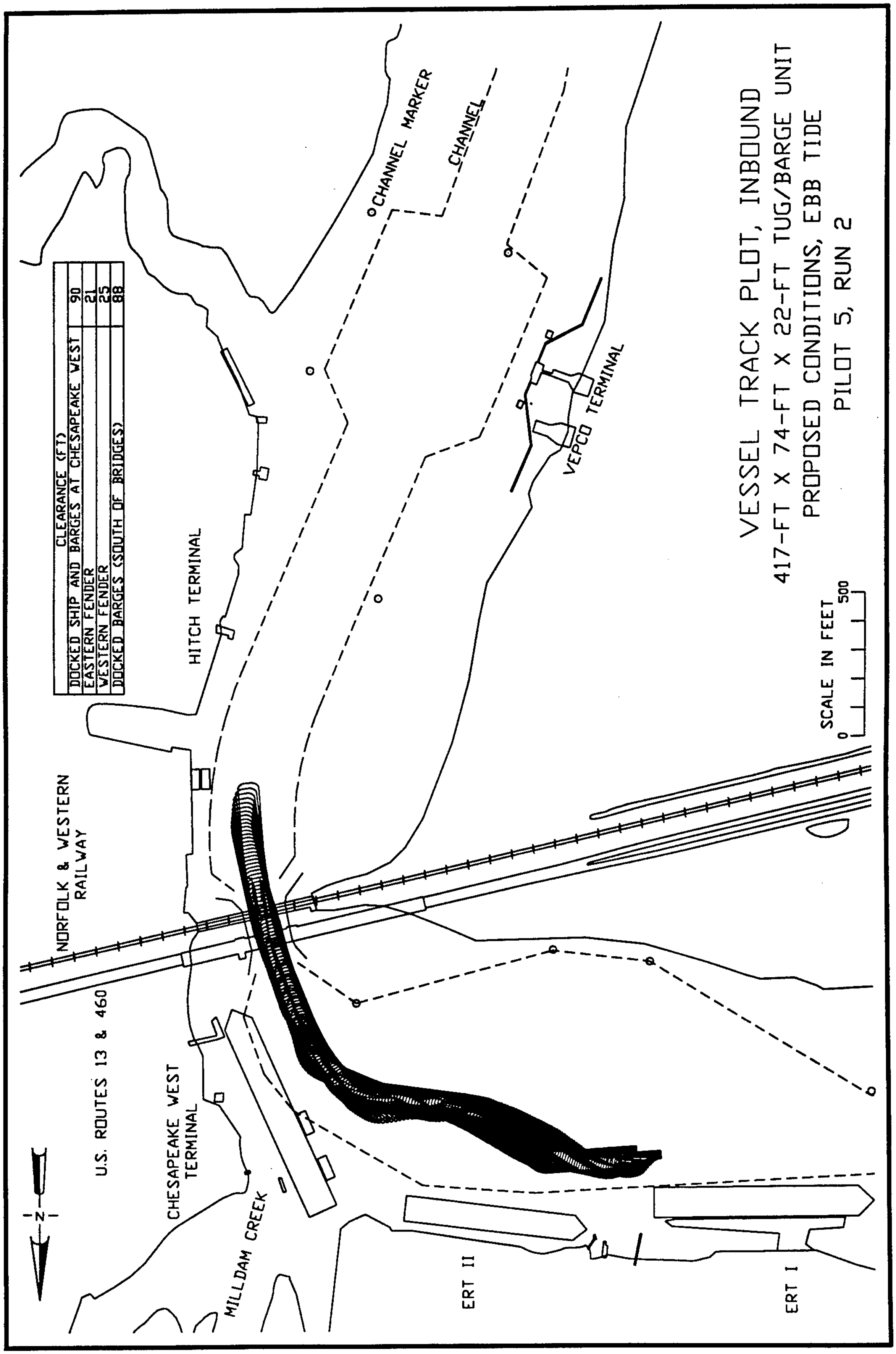

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
PILOT 5, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 90
EASTERN FENDER 21
WESTERN FENDER 25
DOCKED BARGES (SOUTH OF BRIDGES) 88
SCALE IN FEET
0
500
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N

Plate 25

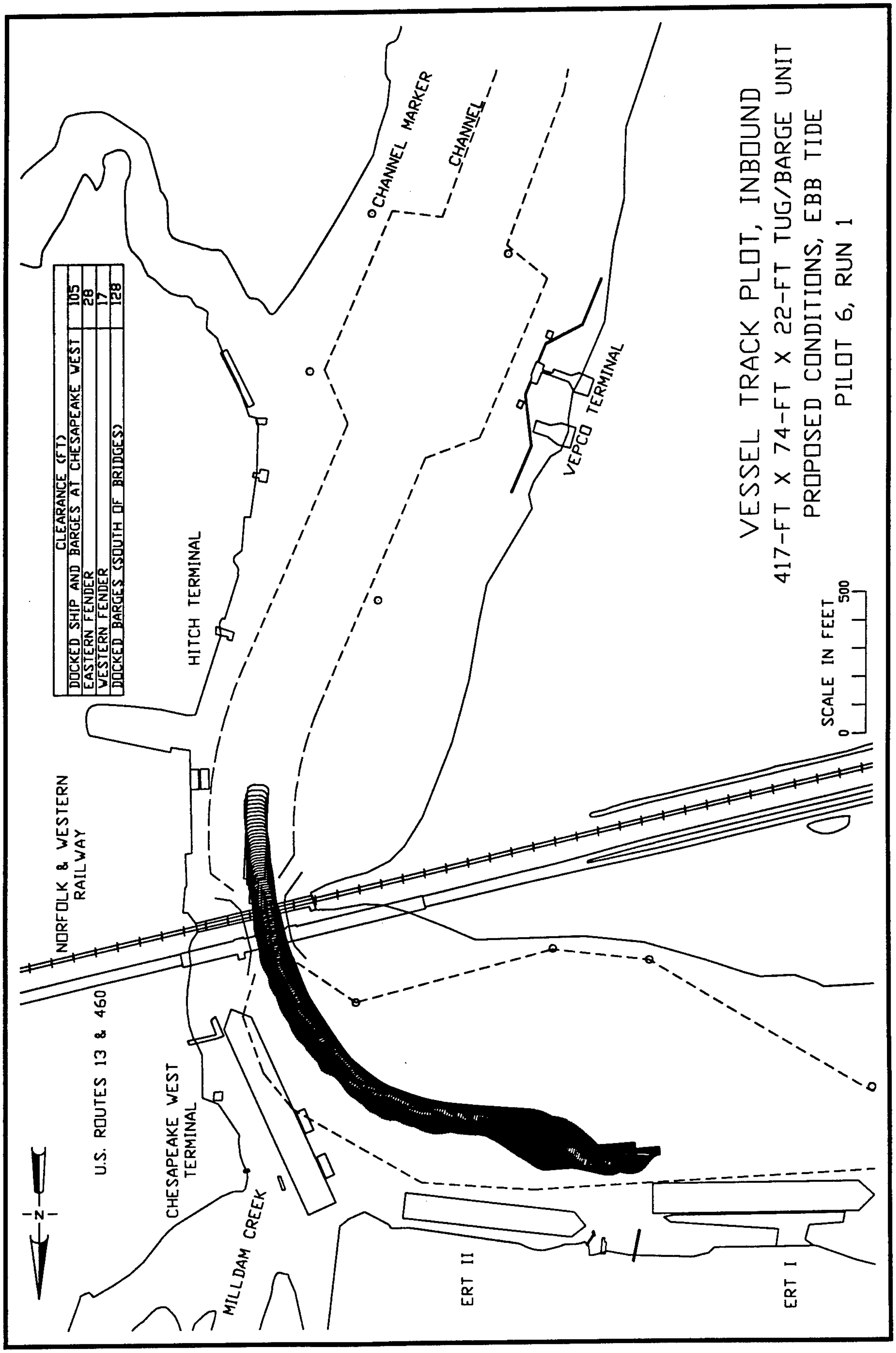
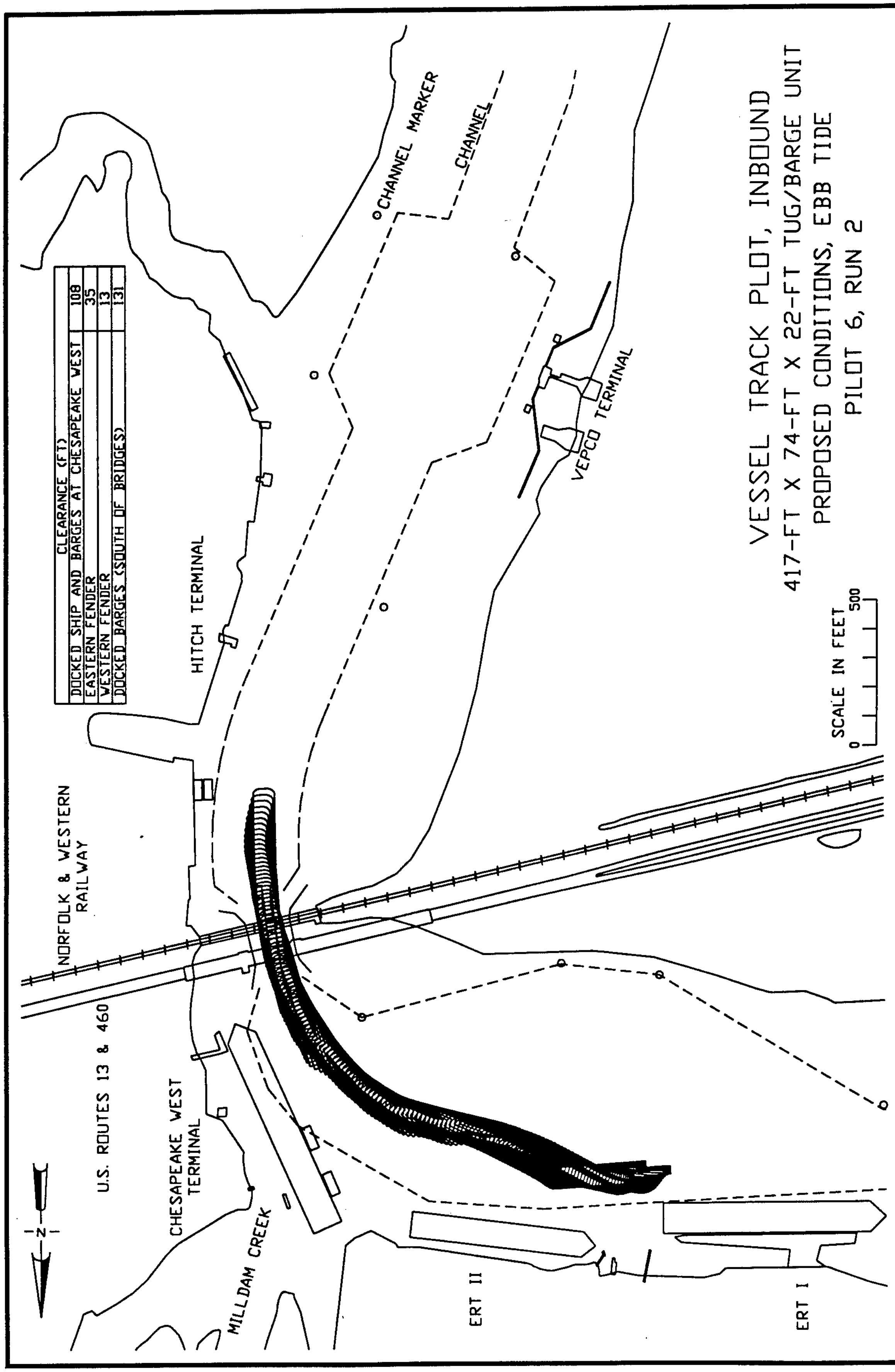

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
PILOT 6, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 105
EASTERN FENDER 28
WESTERN FENDER 17
DOCKED BARGES (SOUTH OF BRIDGES) 128
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 26



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	108
EASTERN FENDER	35
WESTERN FENDER	13
DOCKED BARGES (SOUTH OF BRIDGES)	131

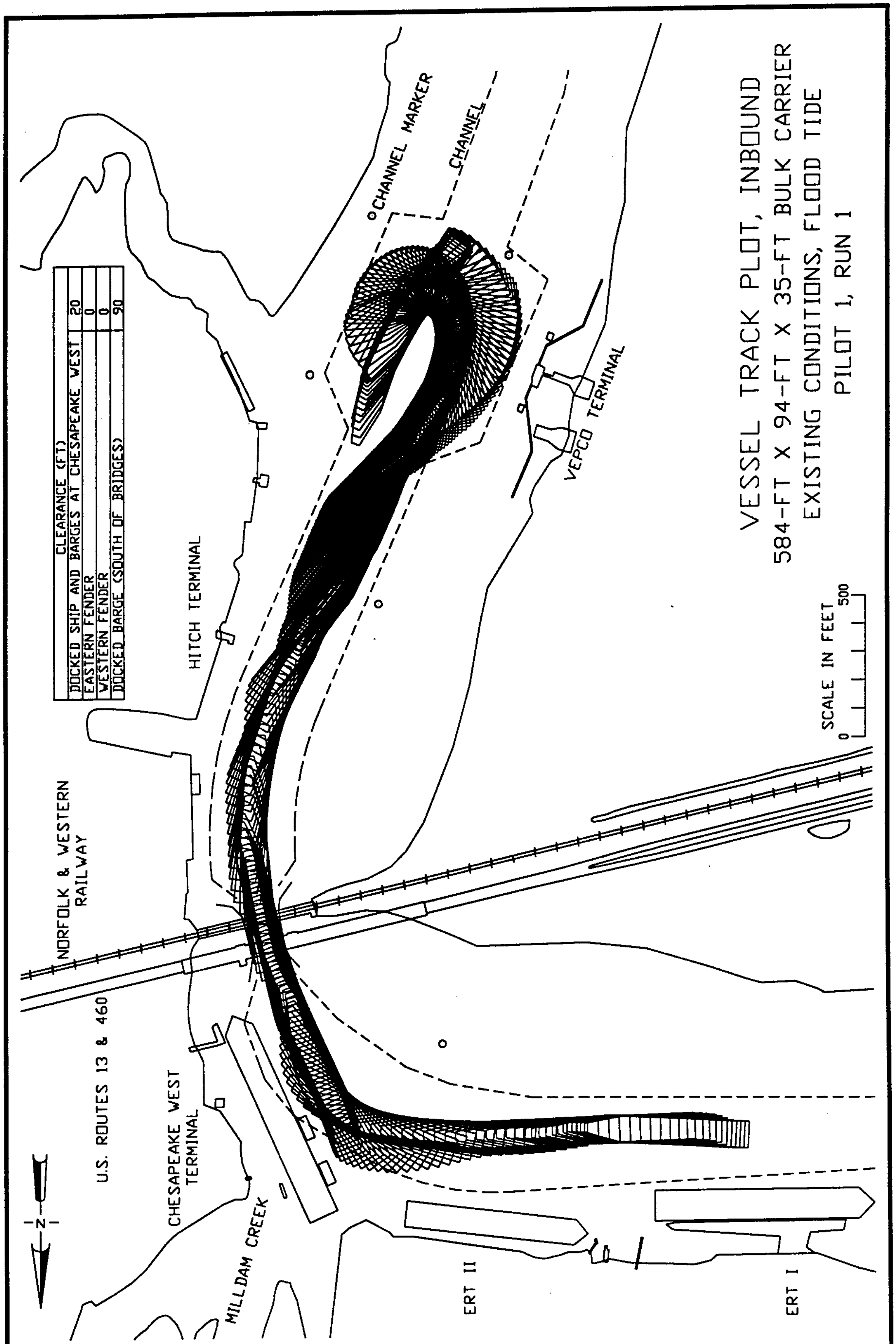
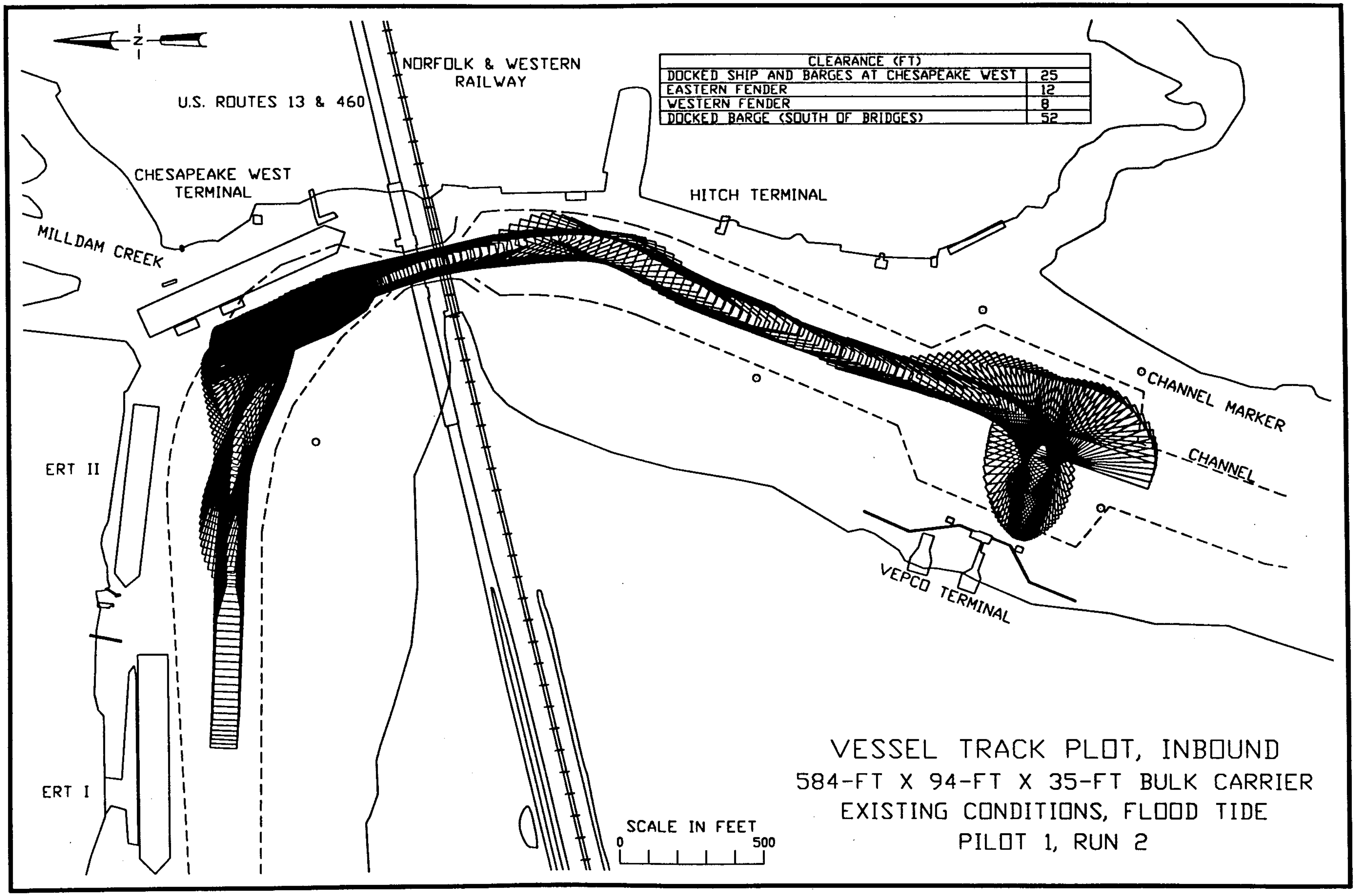

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 1, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 20
EASTERN FENDER 0
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 90
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

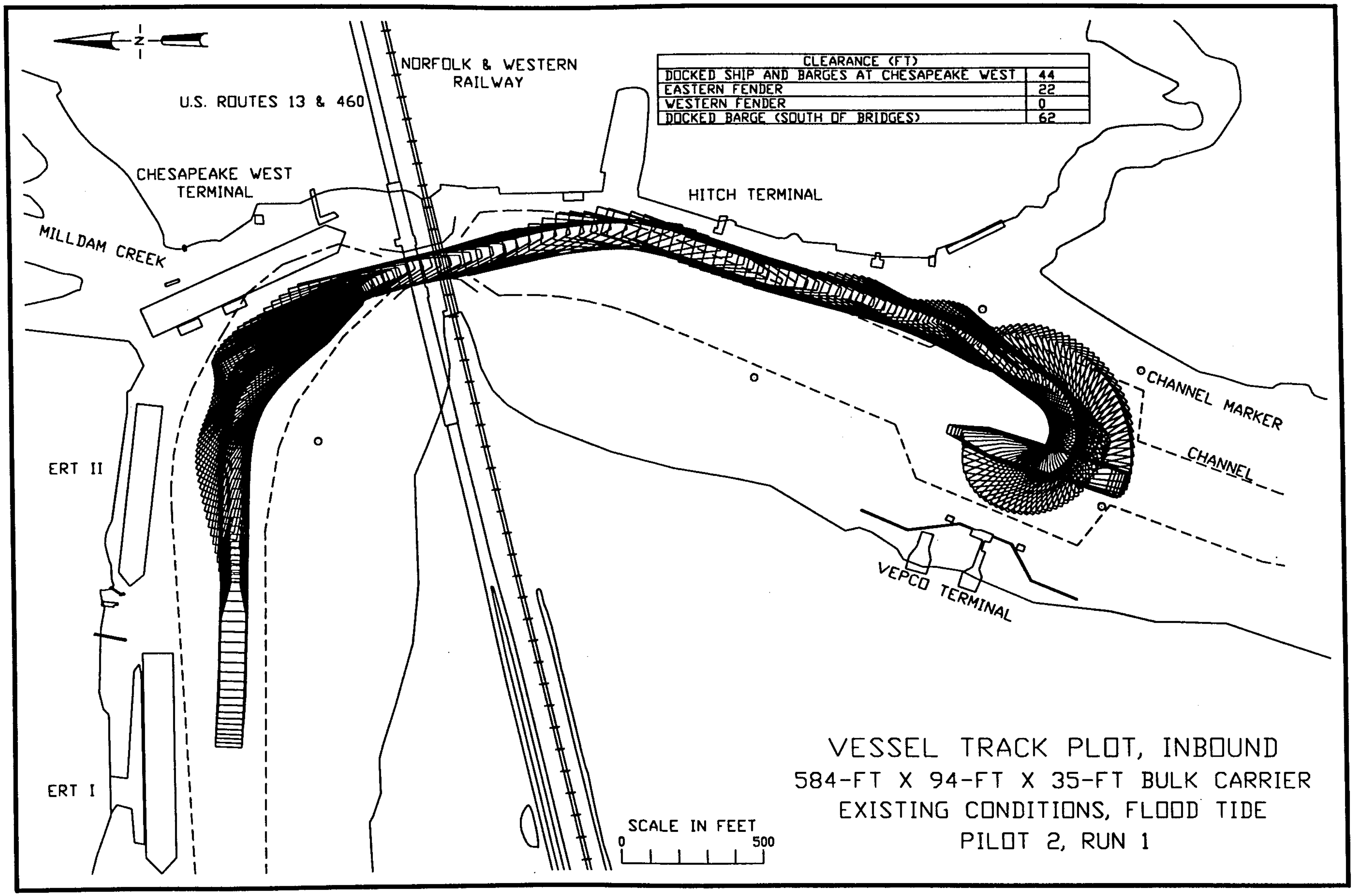
Plate 28



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	25
EASTERN FENDER	12
WESTERN FENDER	8
DOCKED BARGE (SOUTH OF BRIDGES)	52

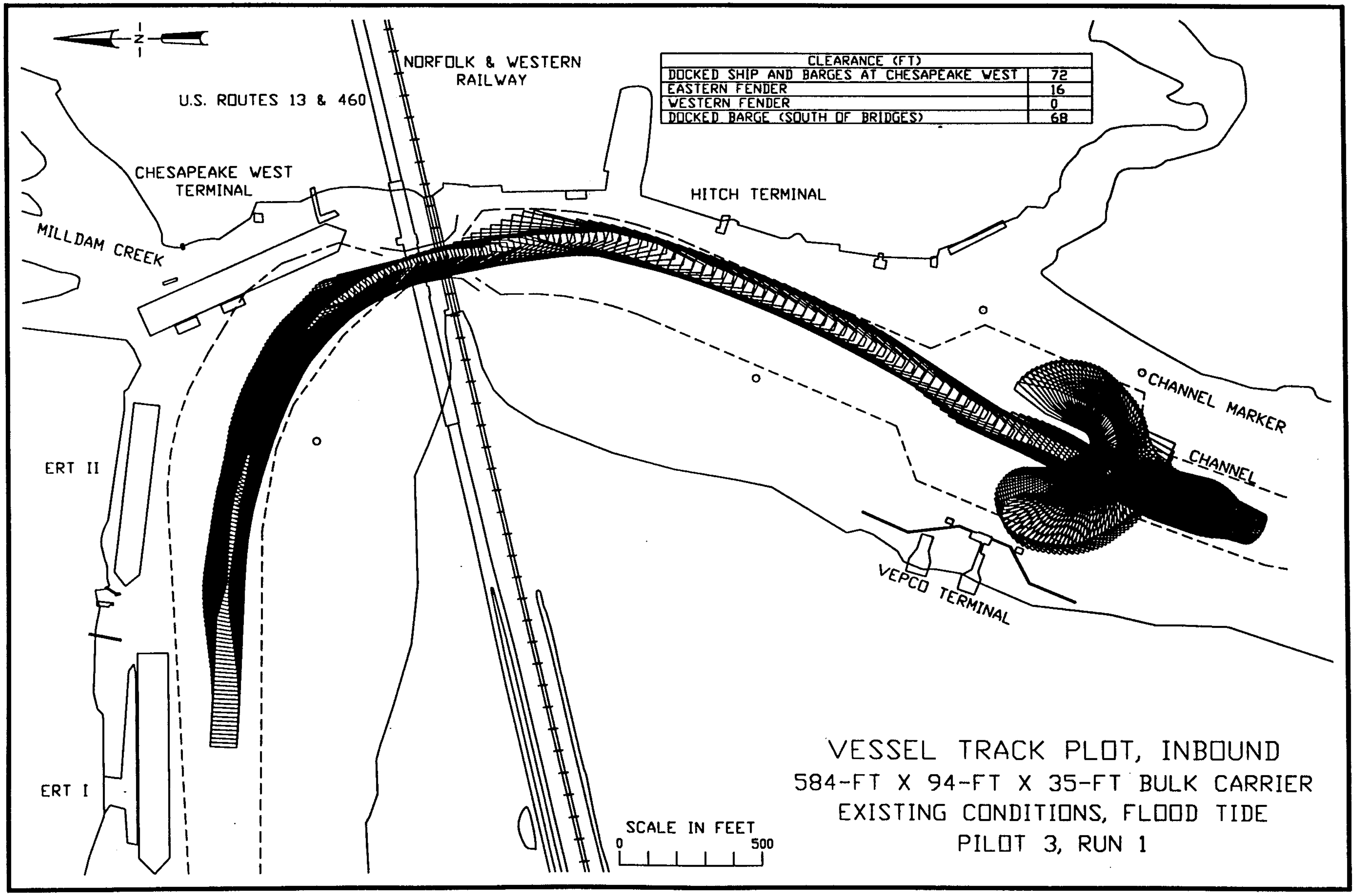
VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 1, RUN 2

Plate 30



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	44
EASTERN FENDER	22
WESTERN FENDER	0
DOCKED BARGE (SOUTH OF BRIDGES)	62

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 2, RUN 1


N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 72
EASTERN FENDER 16
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 68
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3, RUN 1

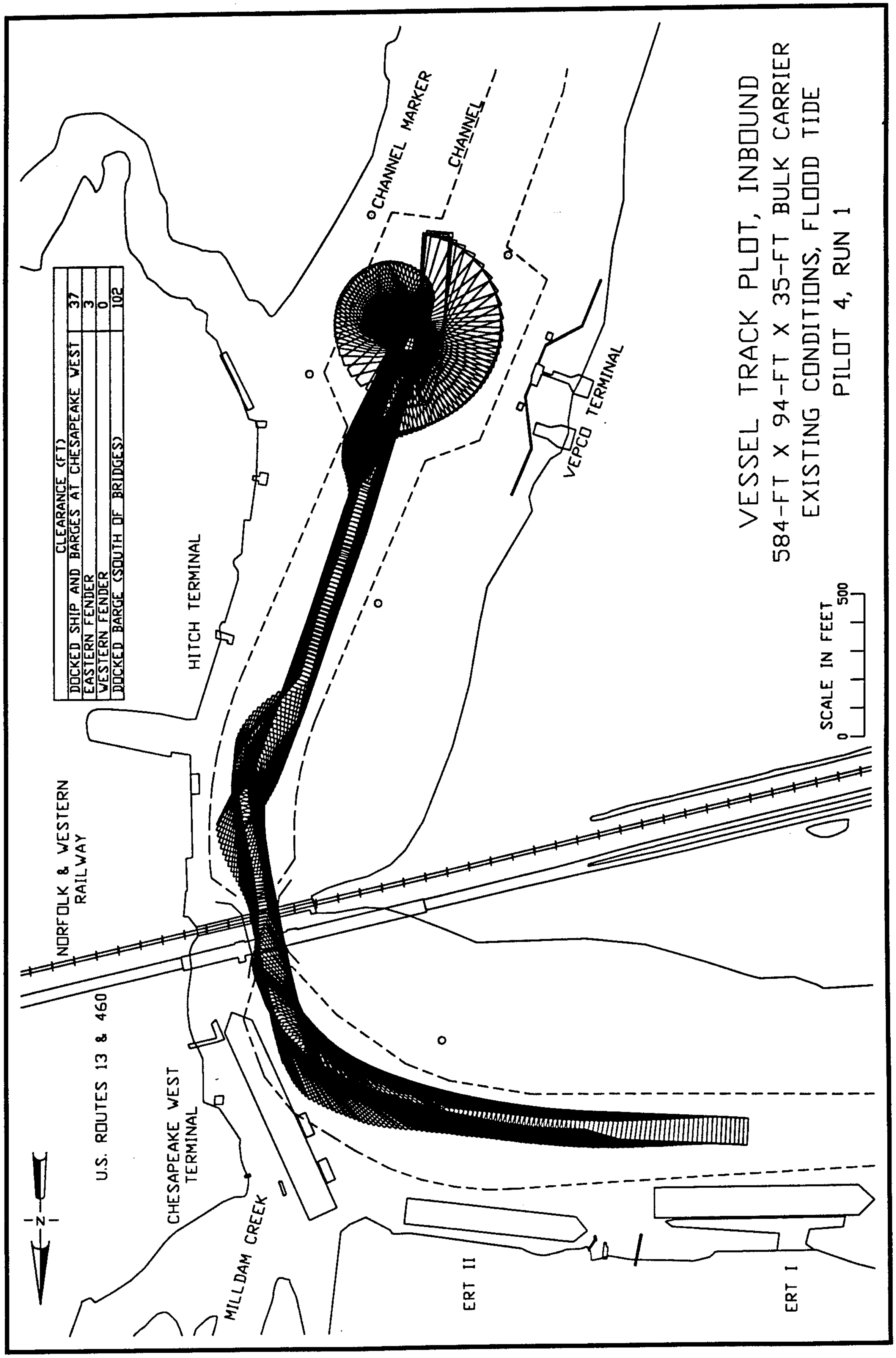
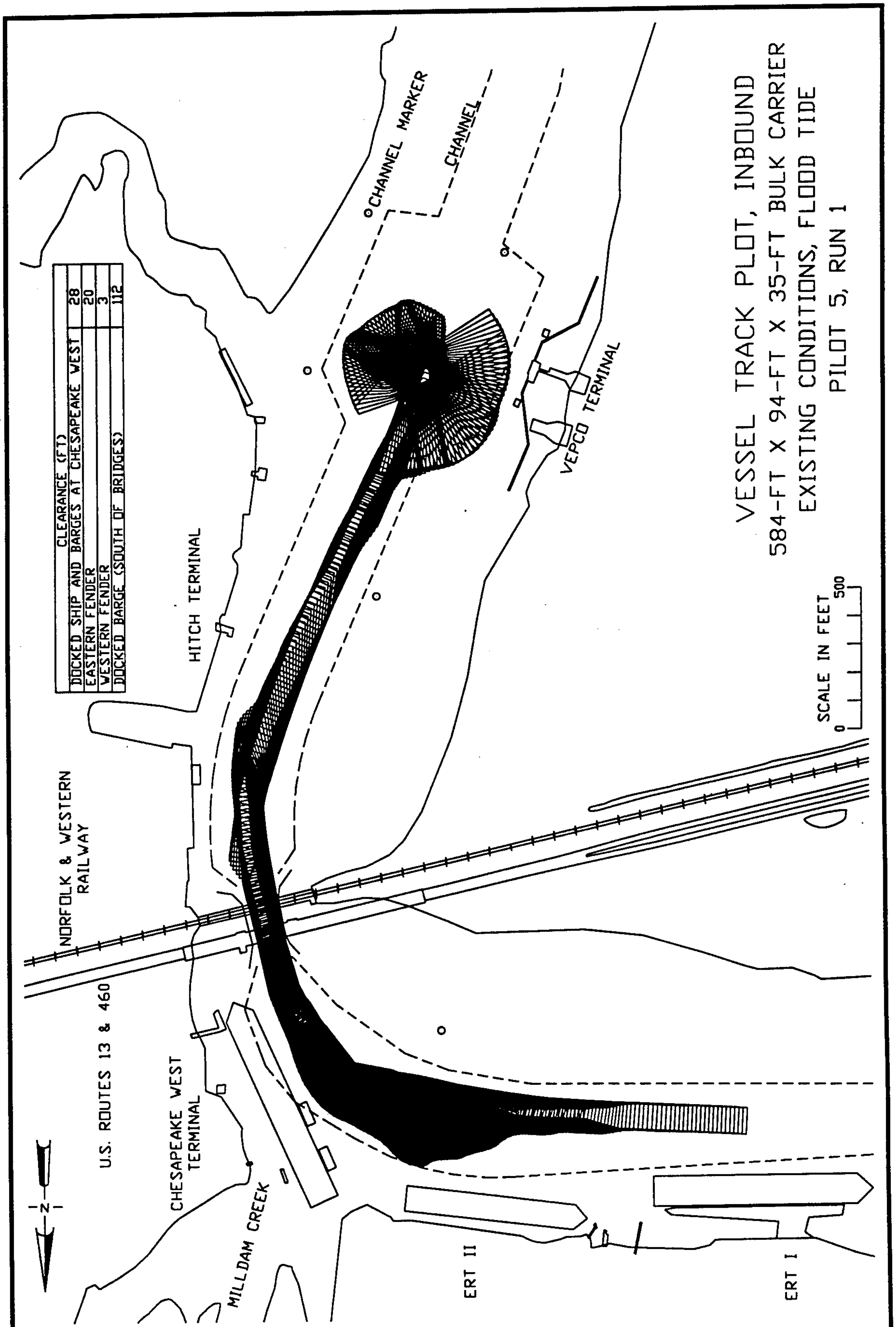

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 37
EASTERN FENDER 3
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 102
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 32



VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 5, RUN 1

Plate 33

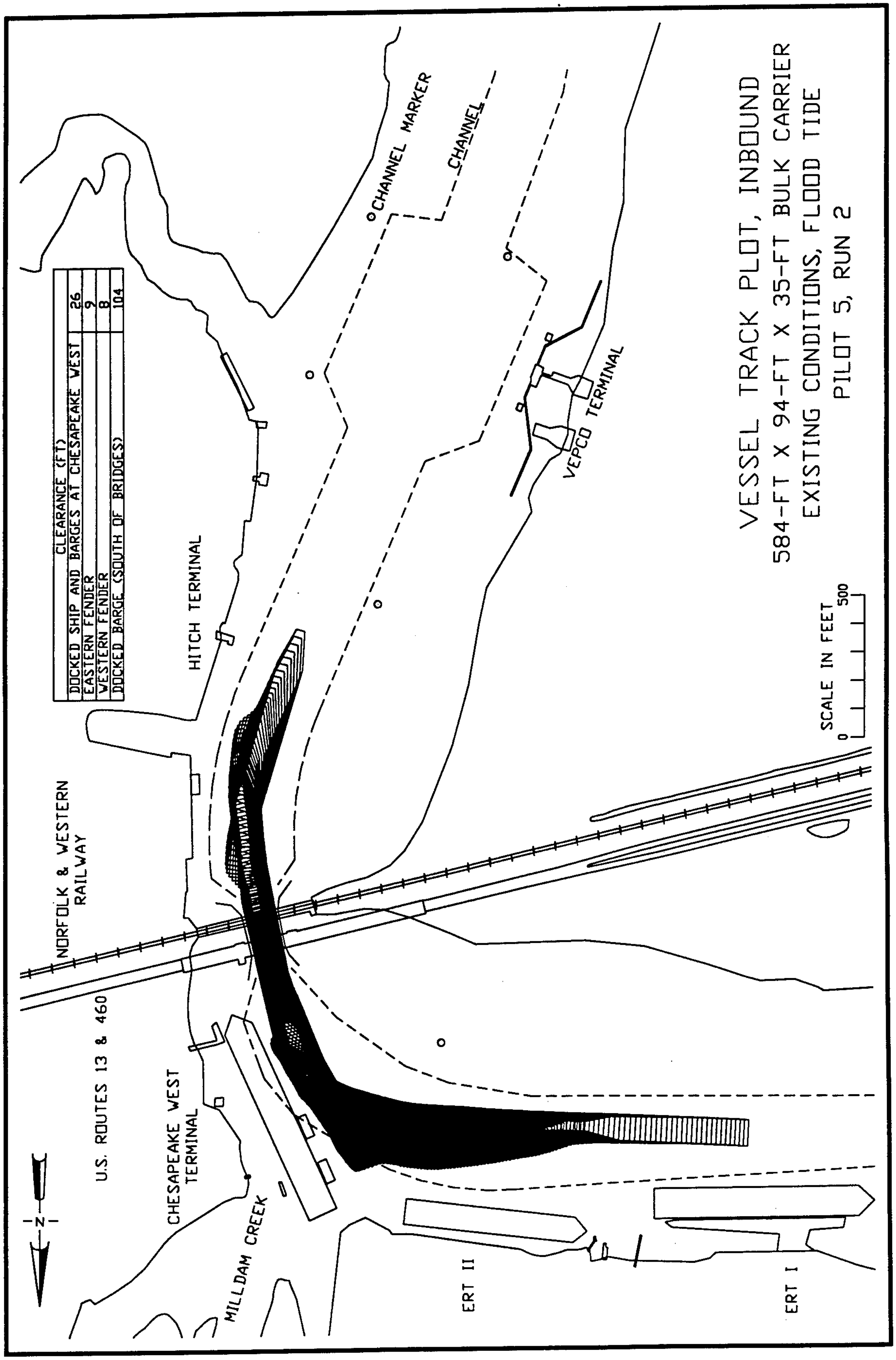
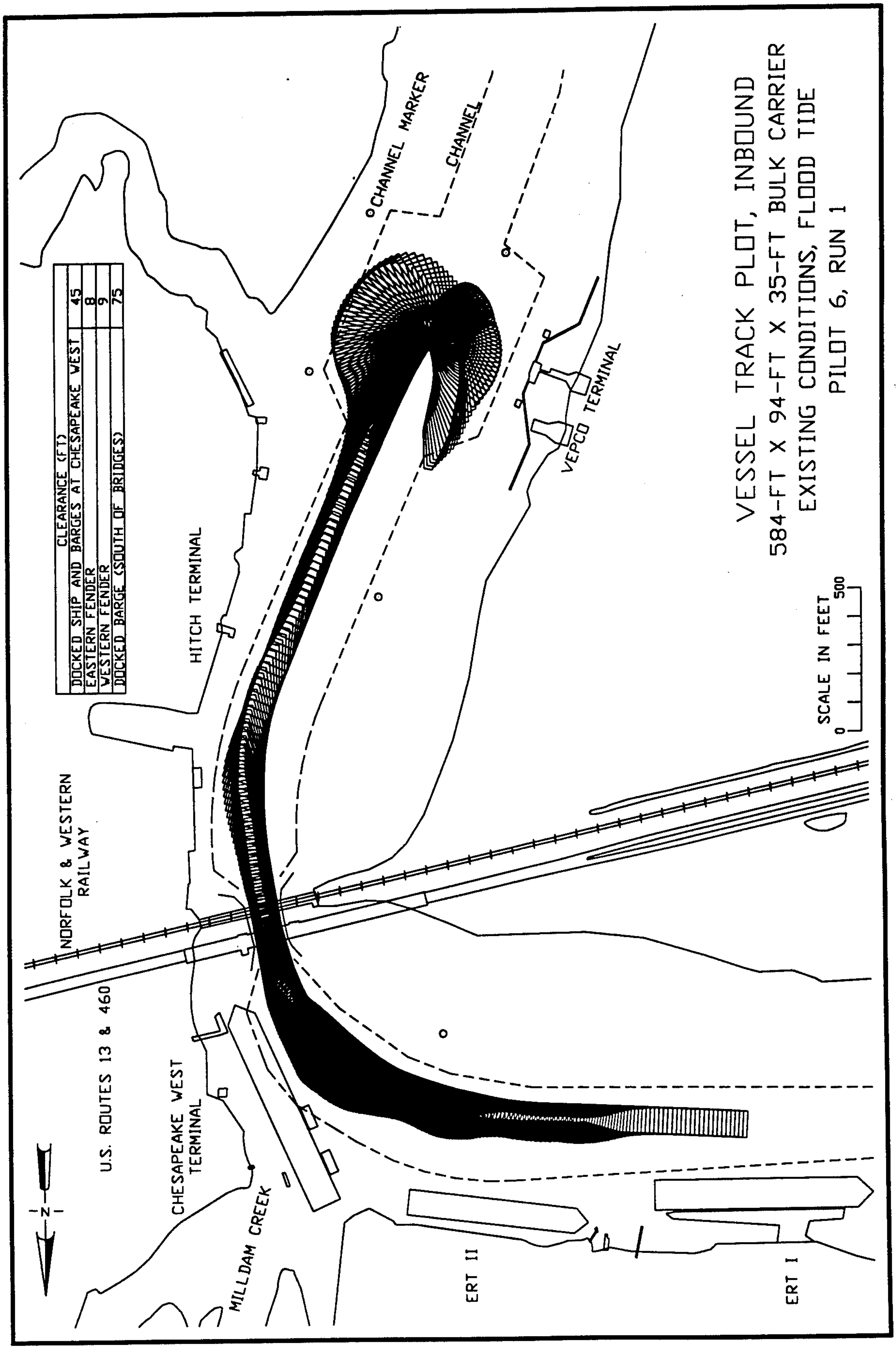

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 5, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 26
EASTERN FENDER 9
WESTERN FENDER 8
DOCKED BARGE (SOUTH OF BRIDGES) 104
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 34


CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 45
EASTERN FENDER 8
WESTERN FENDER 9
DOCKED BARGE (SOUTH OF BRIDGES) 75
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 35-FT BULK CARRIER
EXISTING CONDITIONS, FLOOD TIDE
PILOT 6, RUN 1

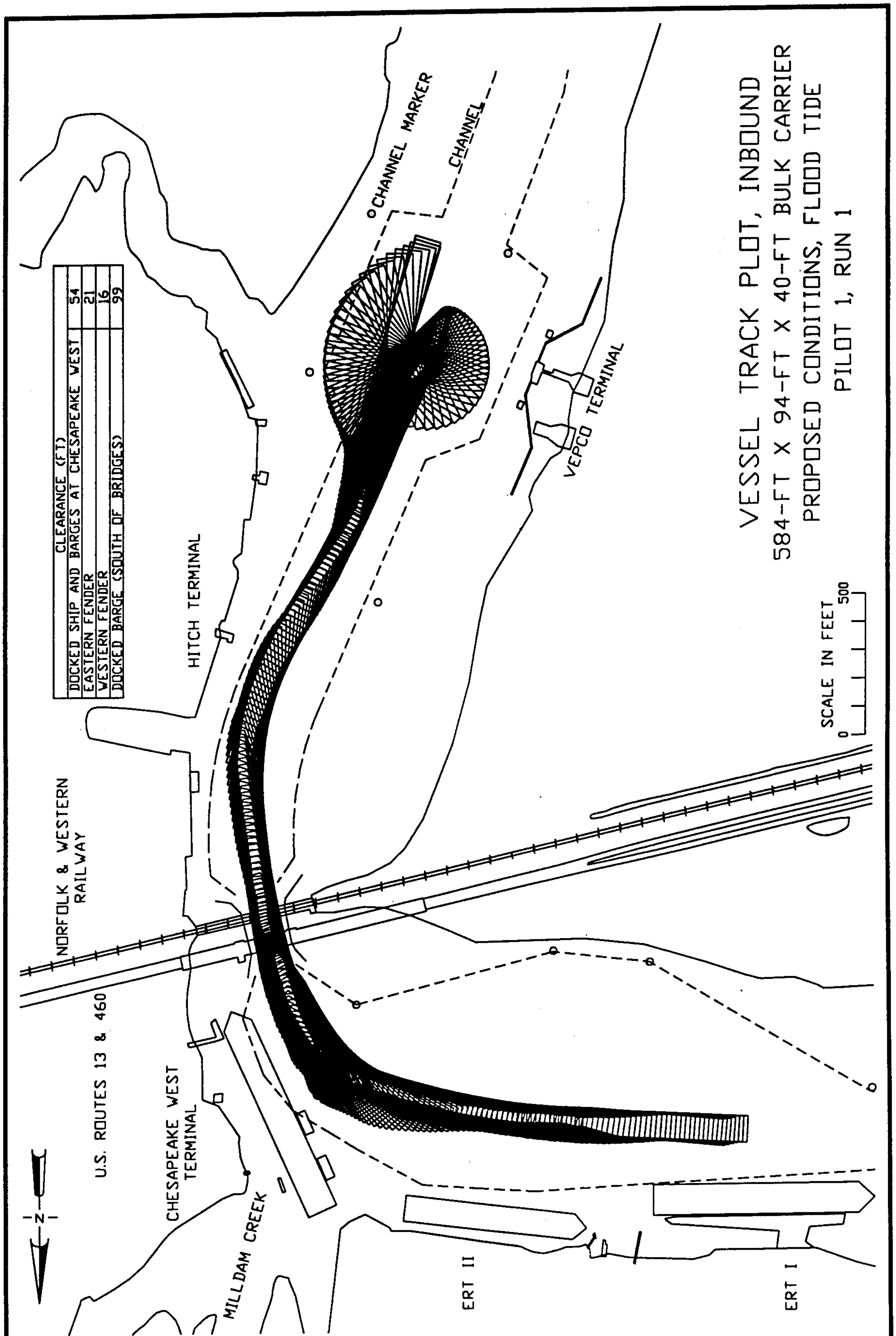
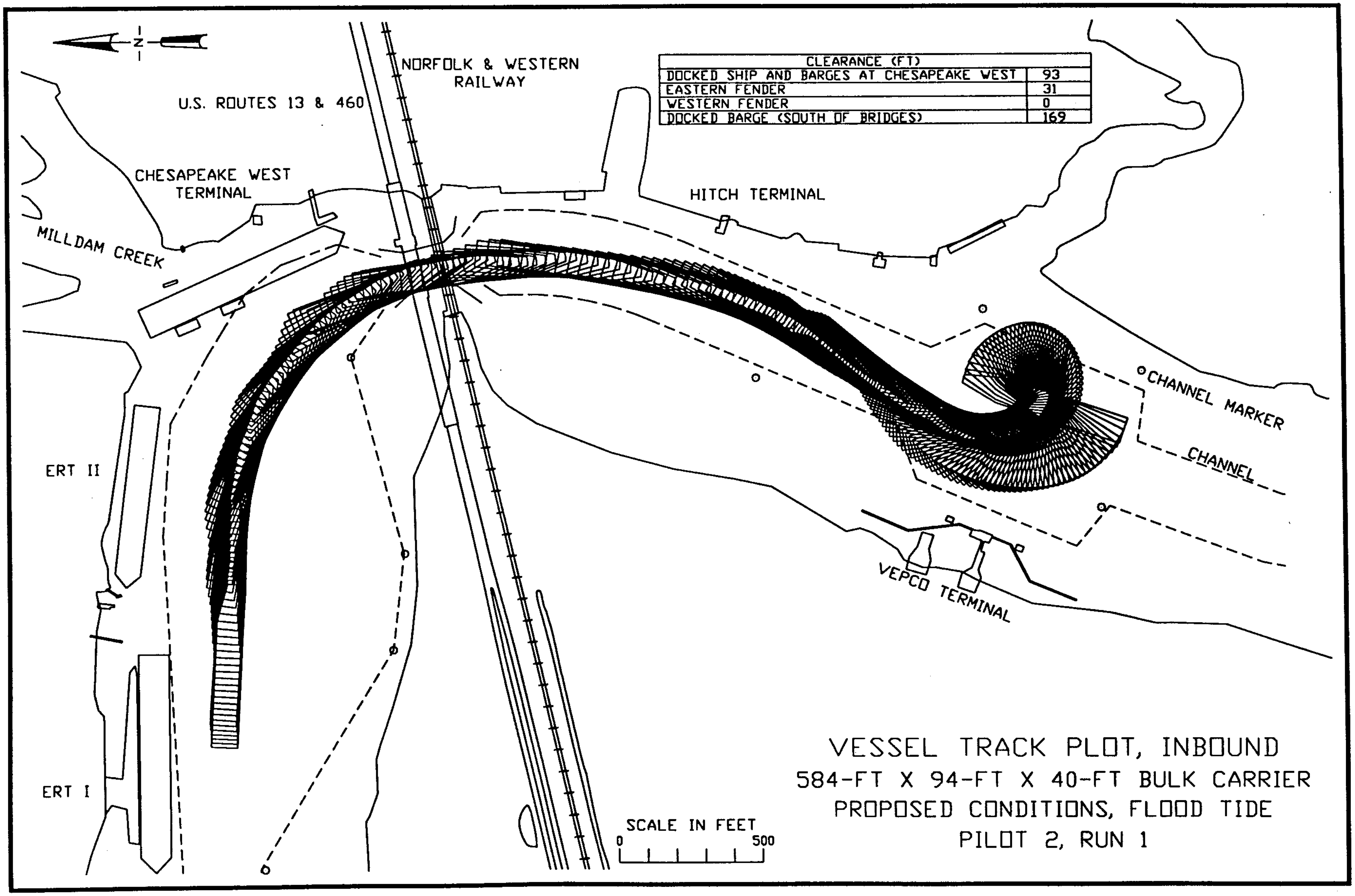
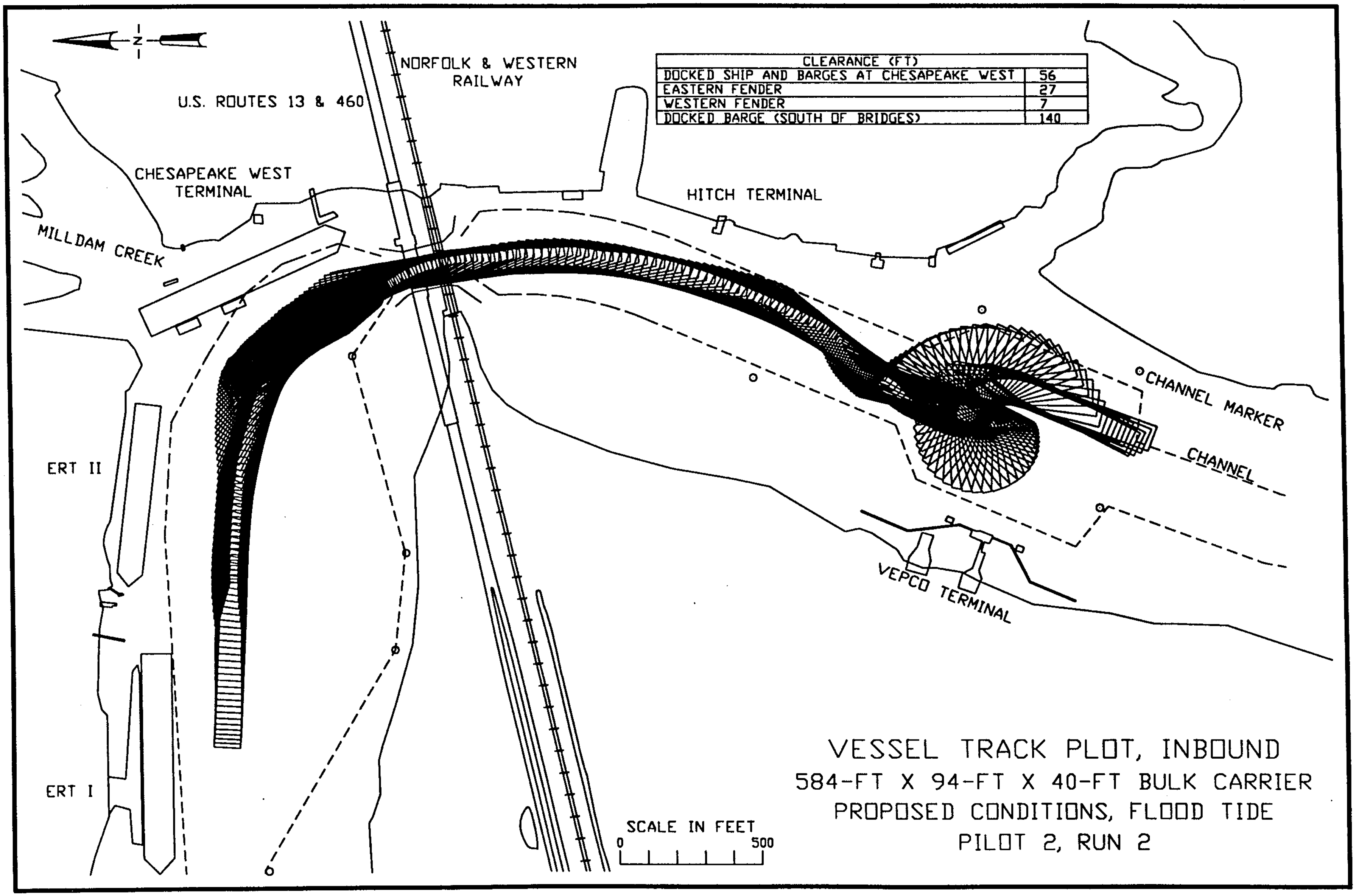

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 1, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 54
EASTERN FENDER 21
WESTERN FENDER 16
DOCKED BARGE (SOUTH OF BRIDGES) 99
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

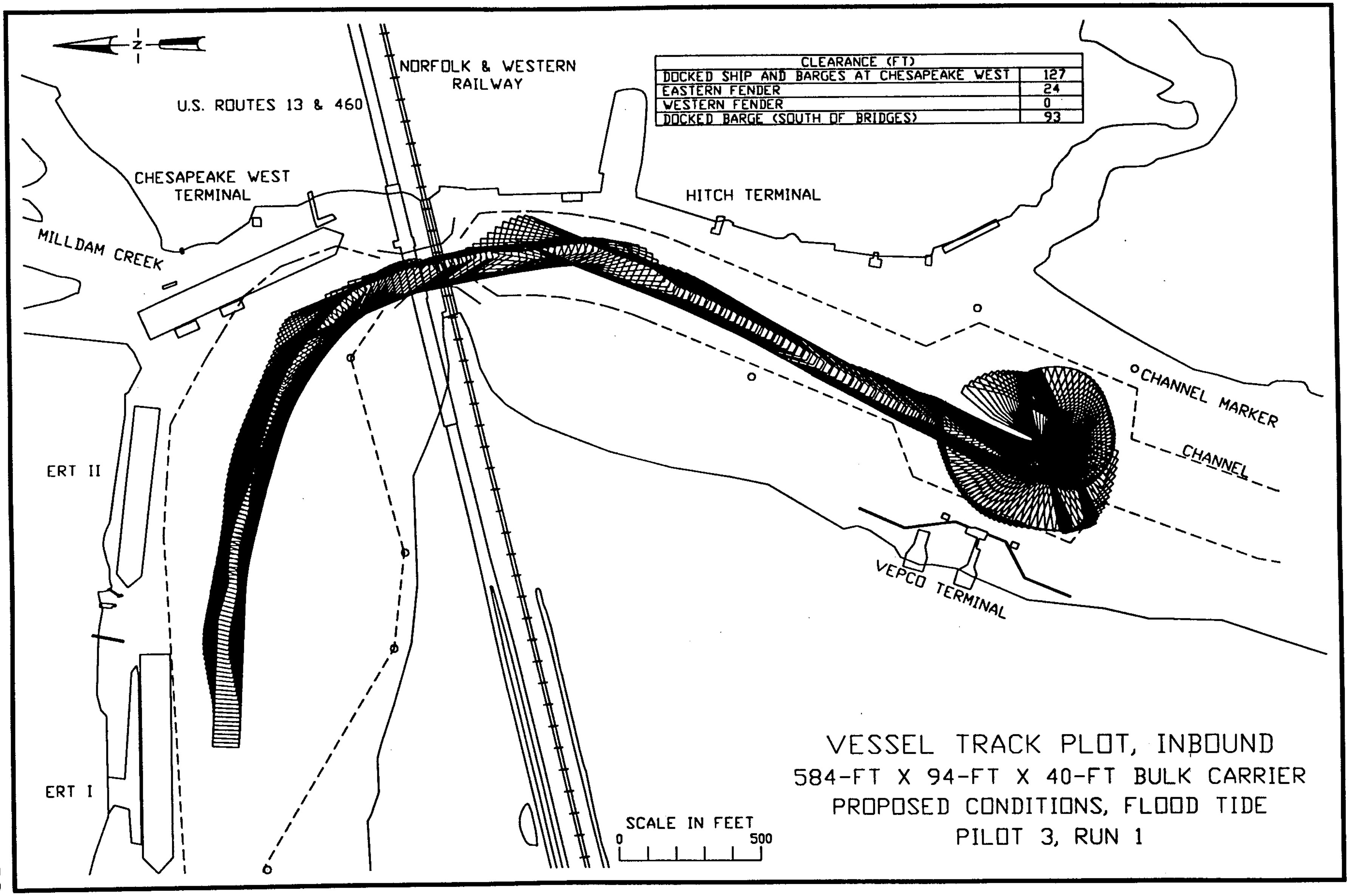
Plate 36


N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 93
EASTERN FENDER 31
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 169
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 2, RUN 1

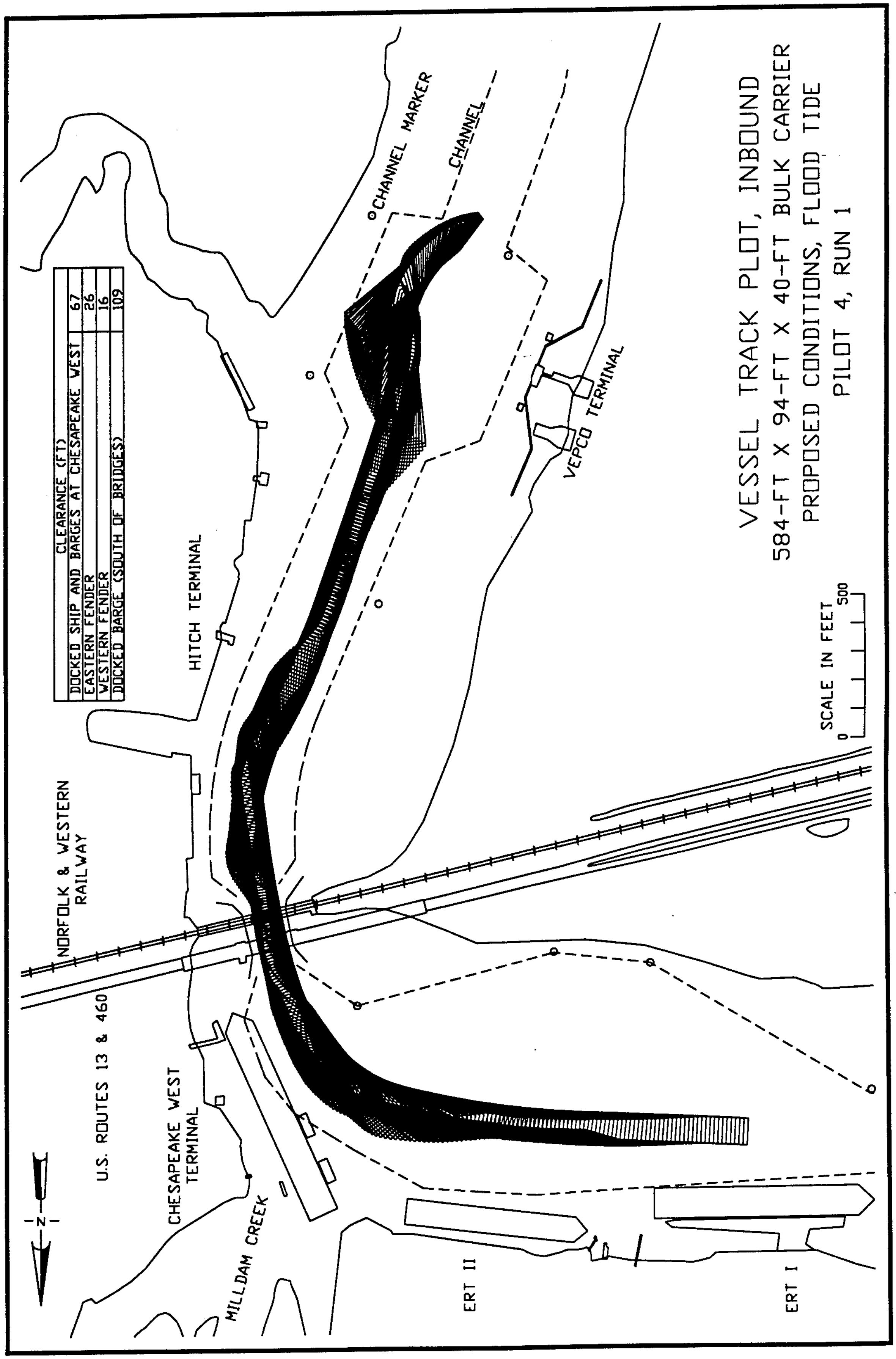


VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 2, RUN 2

Plate 38

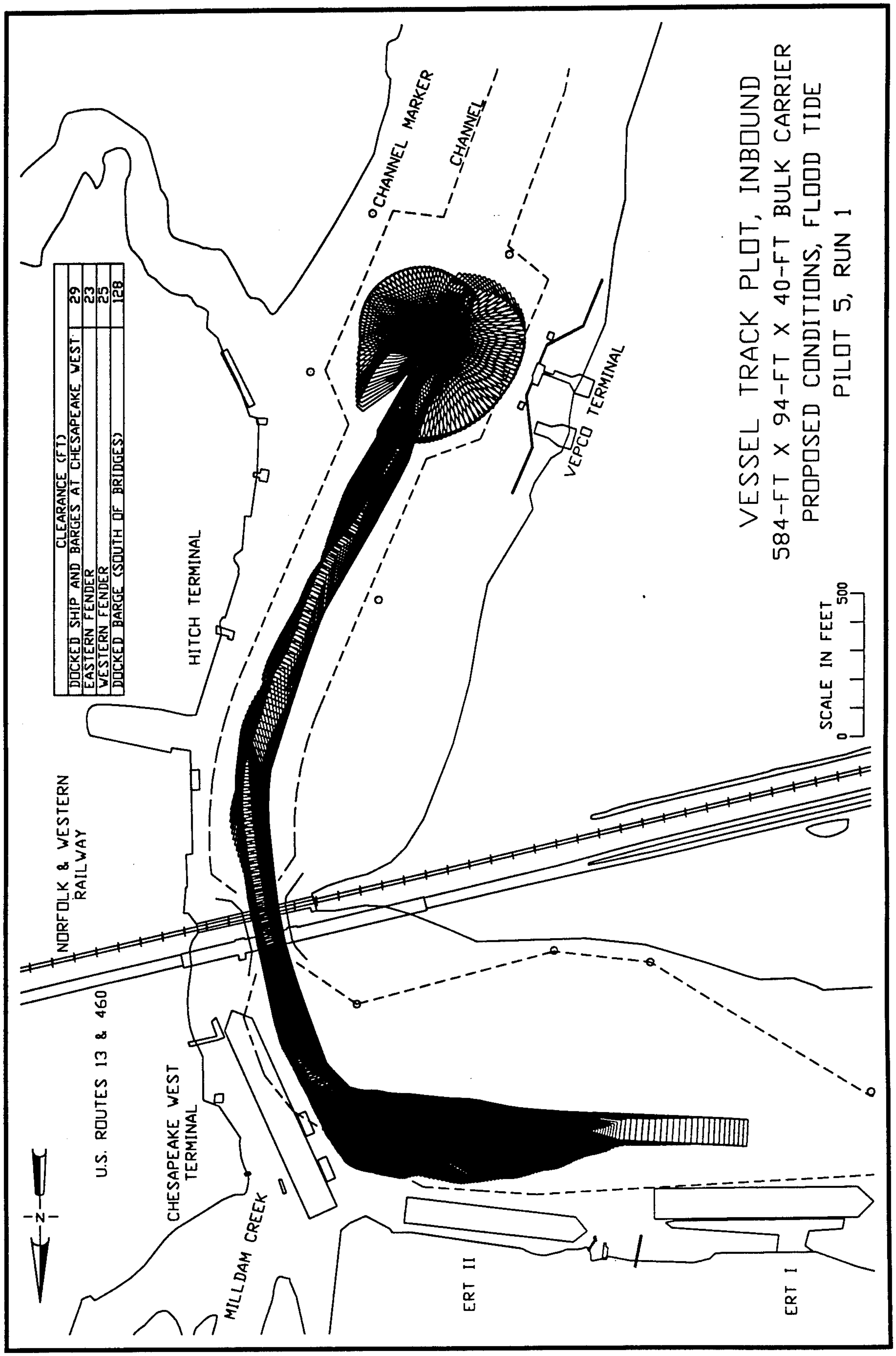


N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
HITCH TERMINAL
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 127
EASTERN FENDER 24
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 93
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
ERT II
ERT I
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 3, RUN 1



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	67
EASTERN FENDER	26
WESTERN FENDER	16
DOCKED BARGE (SOUTH OF BRIDGES)	109

Plate 40



VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 29
EASTERN FENDER 23
WESTERN FENDER 25
DOCKED BARGE (SOUTH OF BRIDGES) 128
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 41

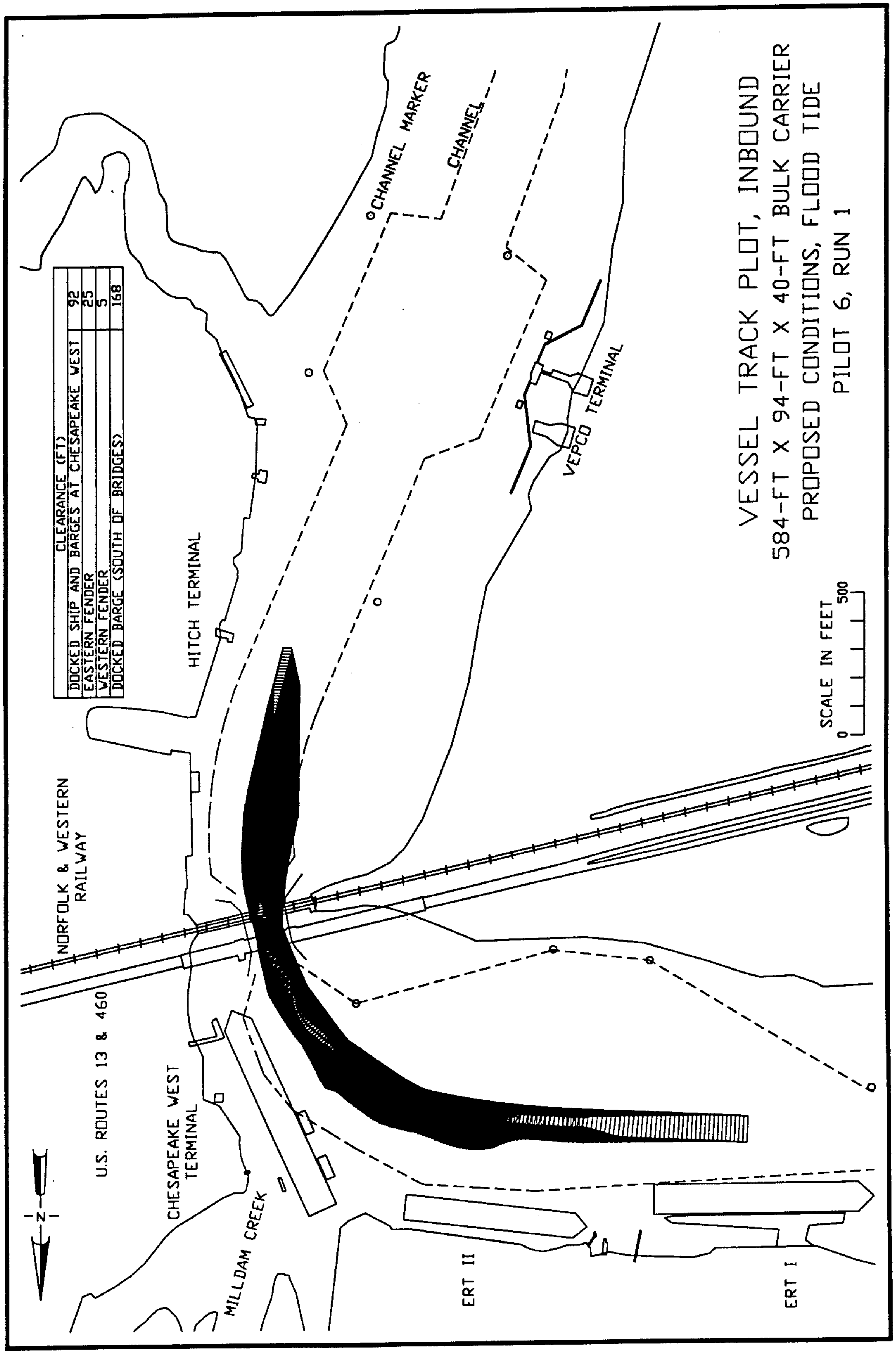
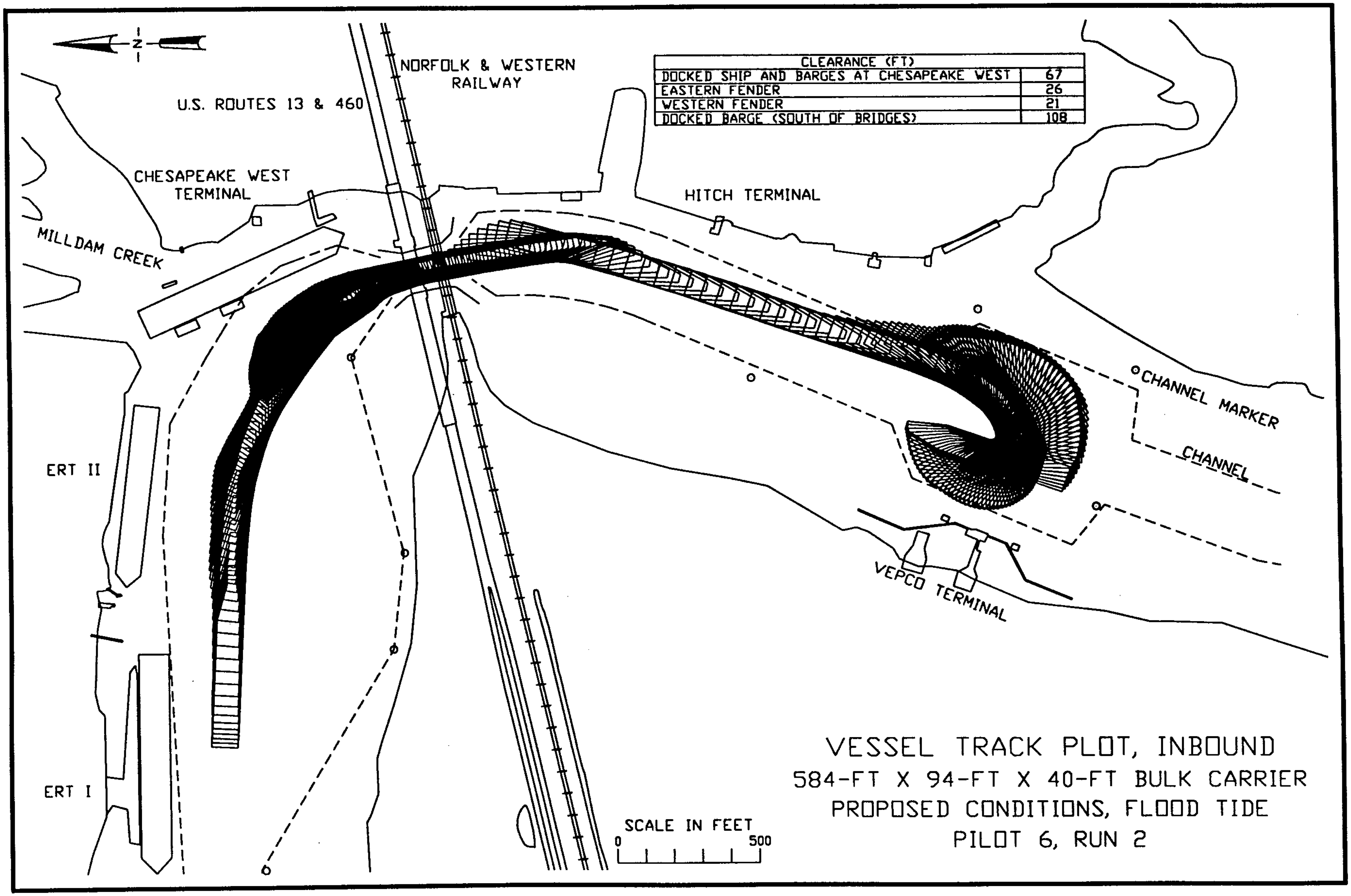
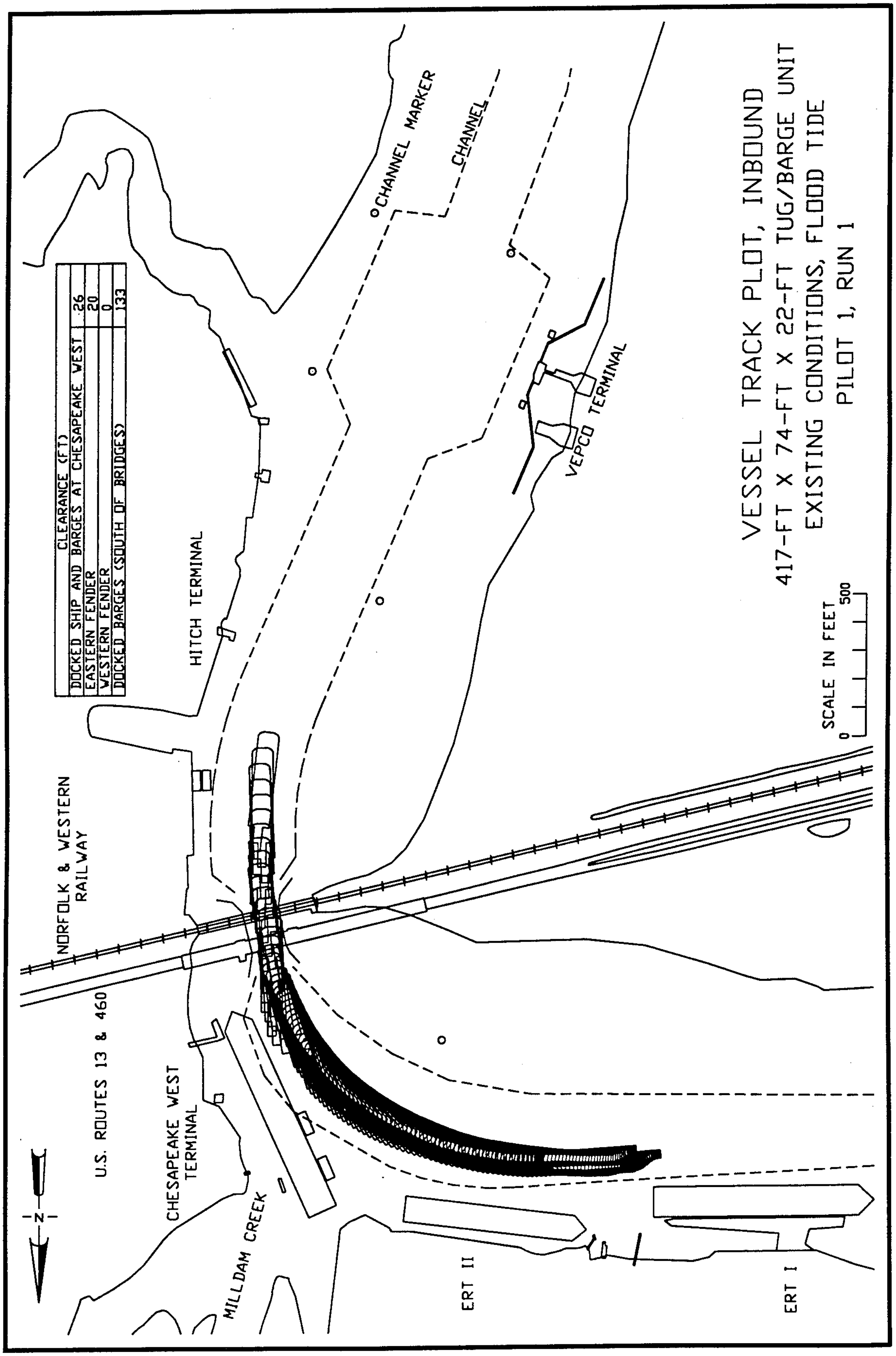

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 92
EASTERN FENDER 25
WESTERN FENDER 5
DOCKED BARGE (SOUTH OF BRIDGES) 168
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 42



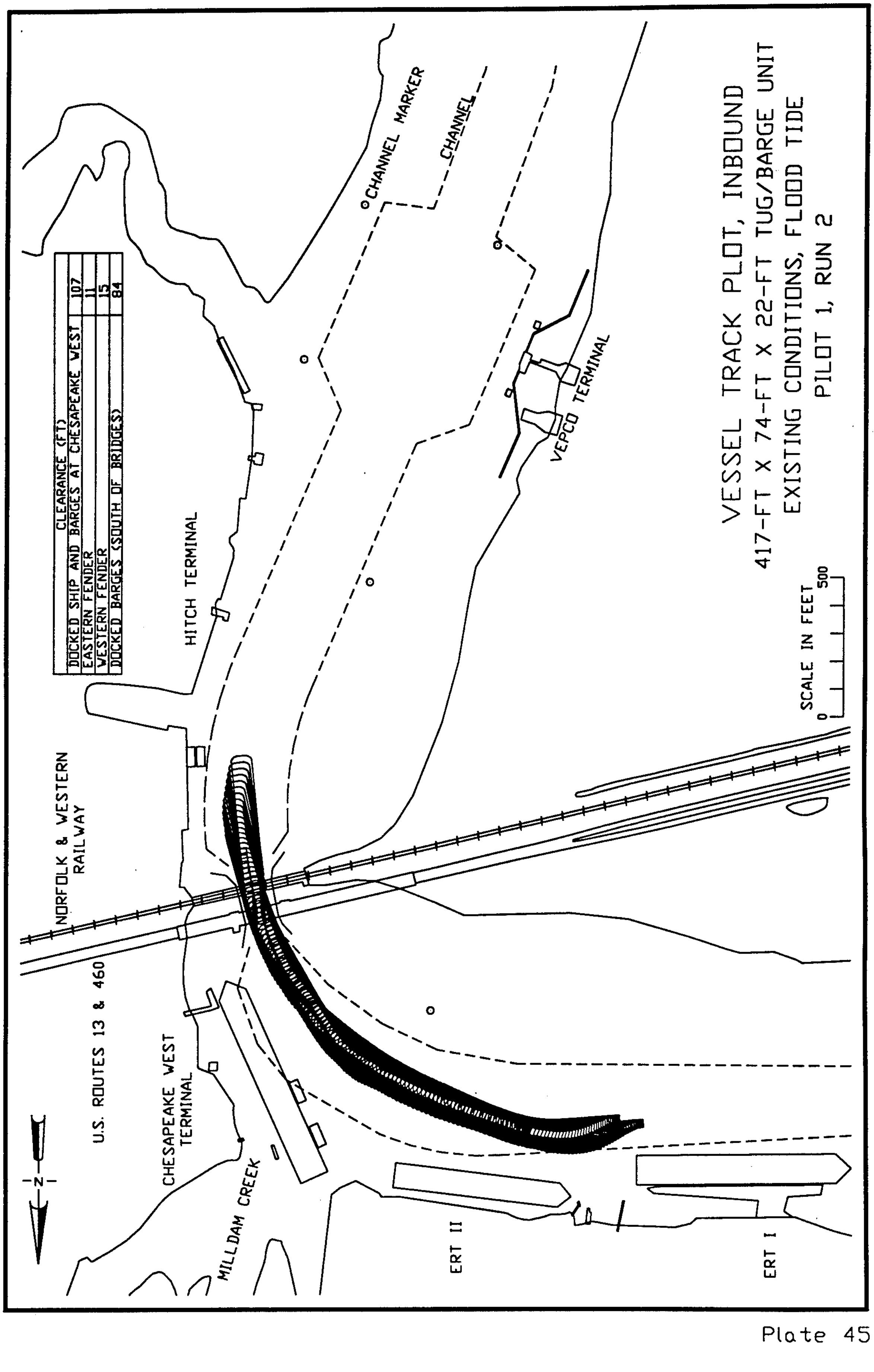
CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	67
EASTERN FENDER	26
WESTERN FENDER	21
DOCKED BARGE (SOUTH OF BRIDGES)	108

VESSEL TRACK PLOT, INBOUND
584-FT X 94-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6, RUN 2



VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 1, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 26
EASTERN FENDER 20
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 133
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 44



VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 1, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 107
EASTERN FENDER 11
WESTERN FENDER 15
DOCKED BARGES (SOUTH OF BRIDGES) 84
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

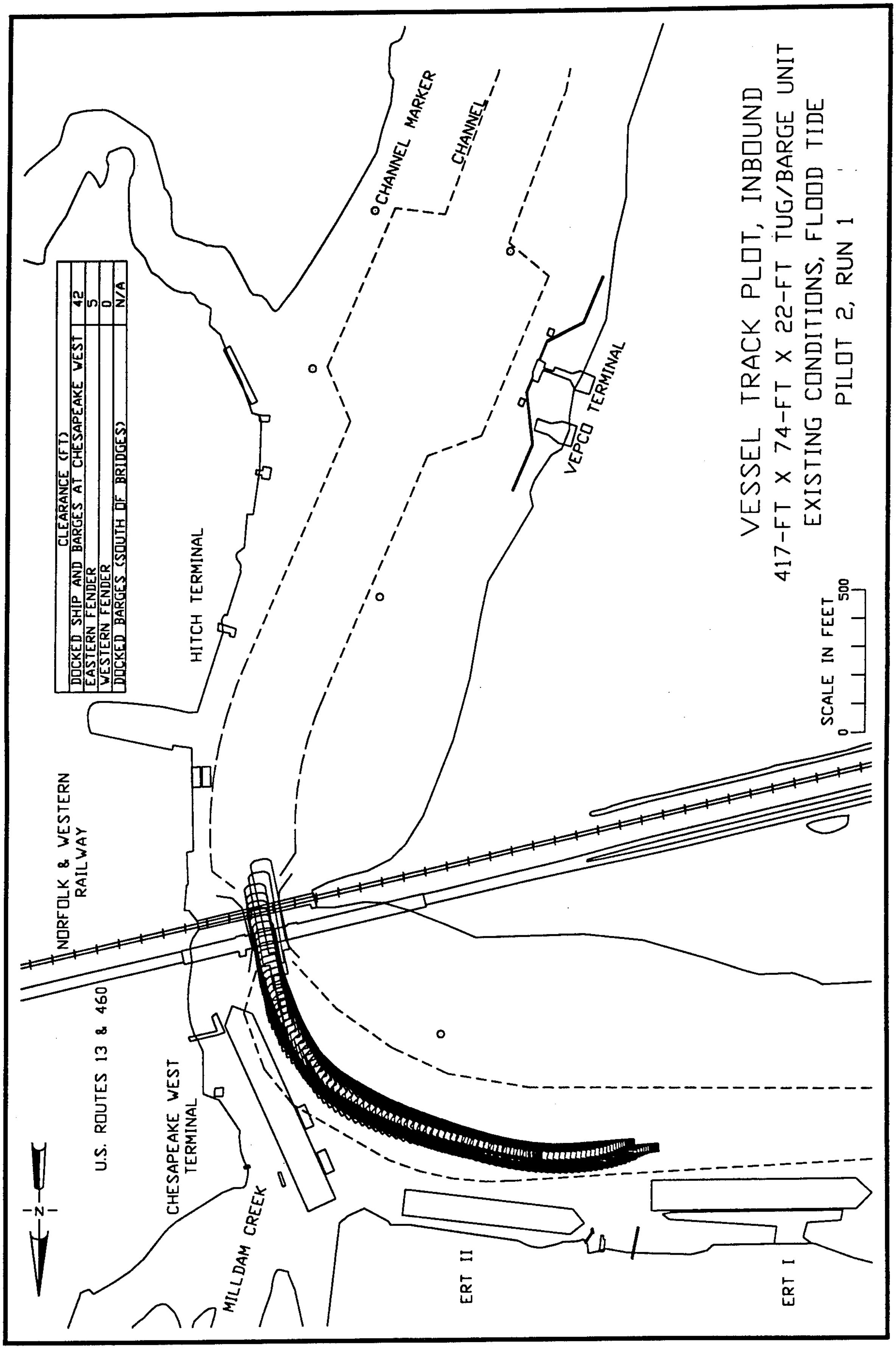
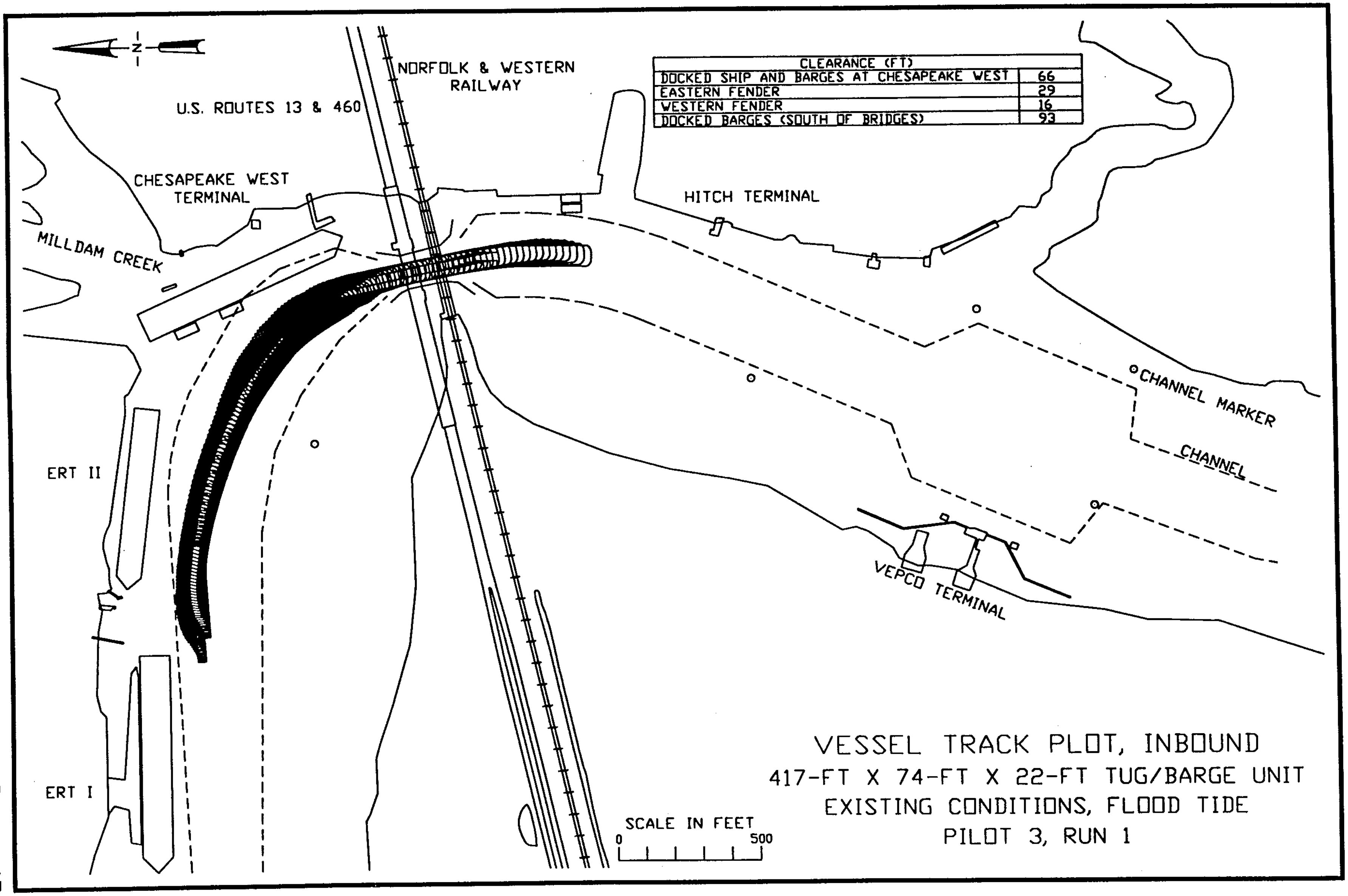

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 2, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 42
EASTERN FENDER 5
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) N/A
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 46



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	66
EASTERN FENDER	29
WESTERN FENDER	16
DOCKED BARGES (SOUTH OF BRIDGES)	93

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 3, RUN 1

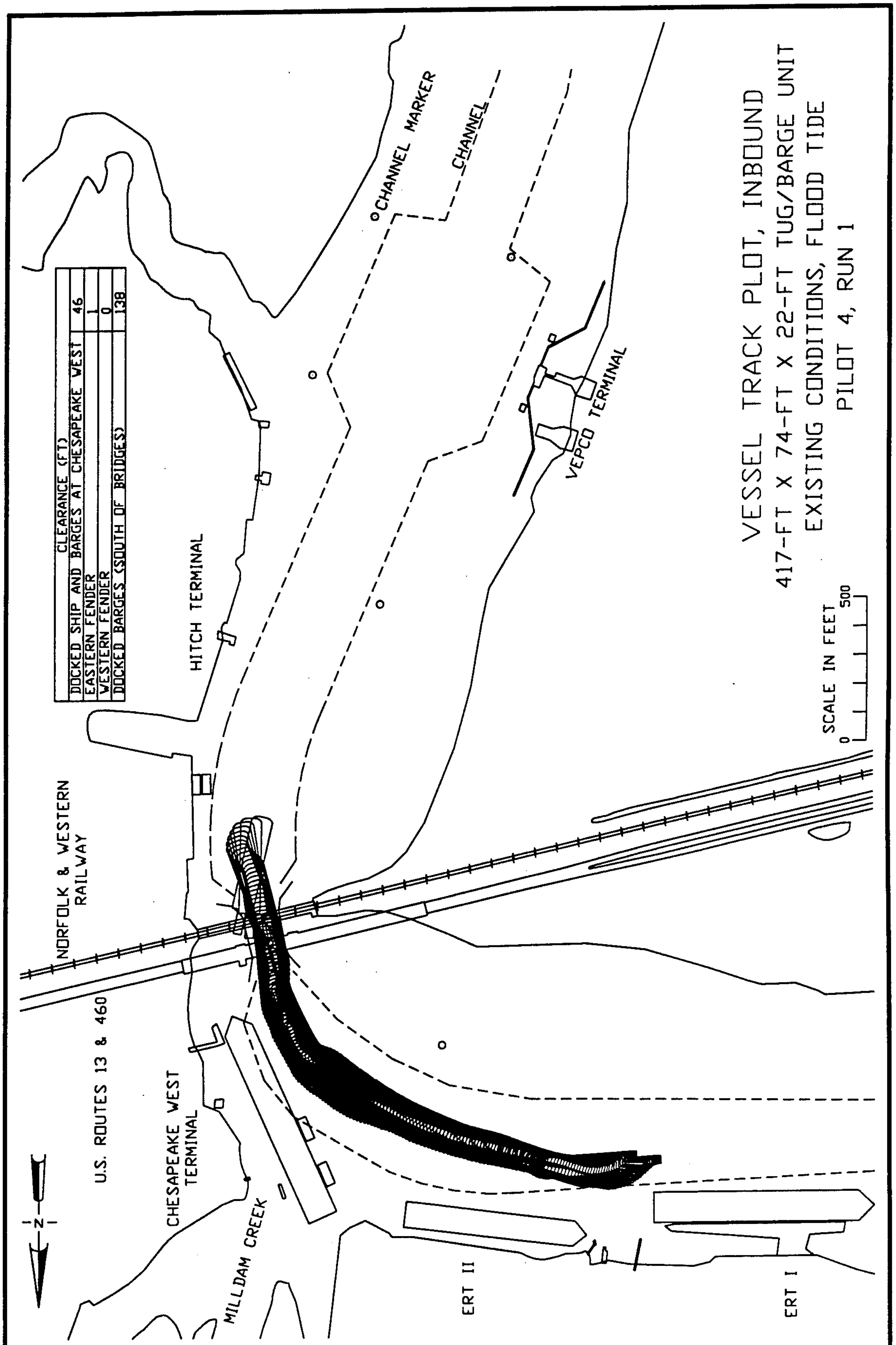
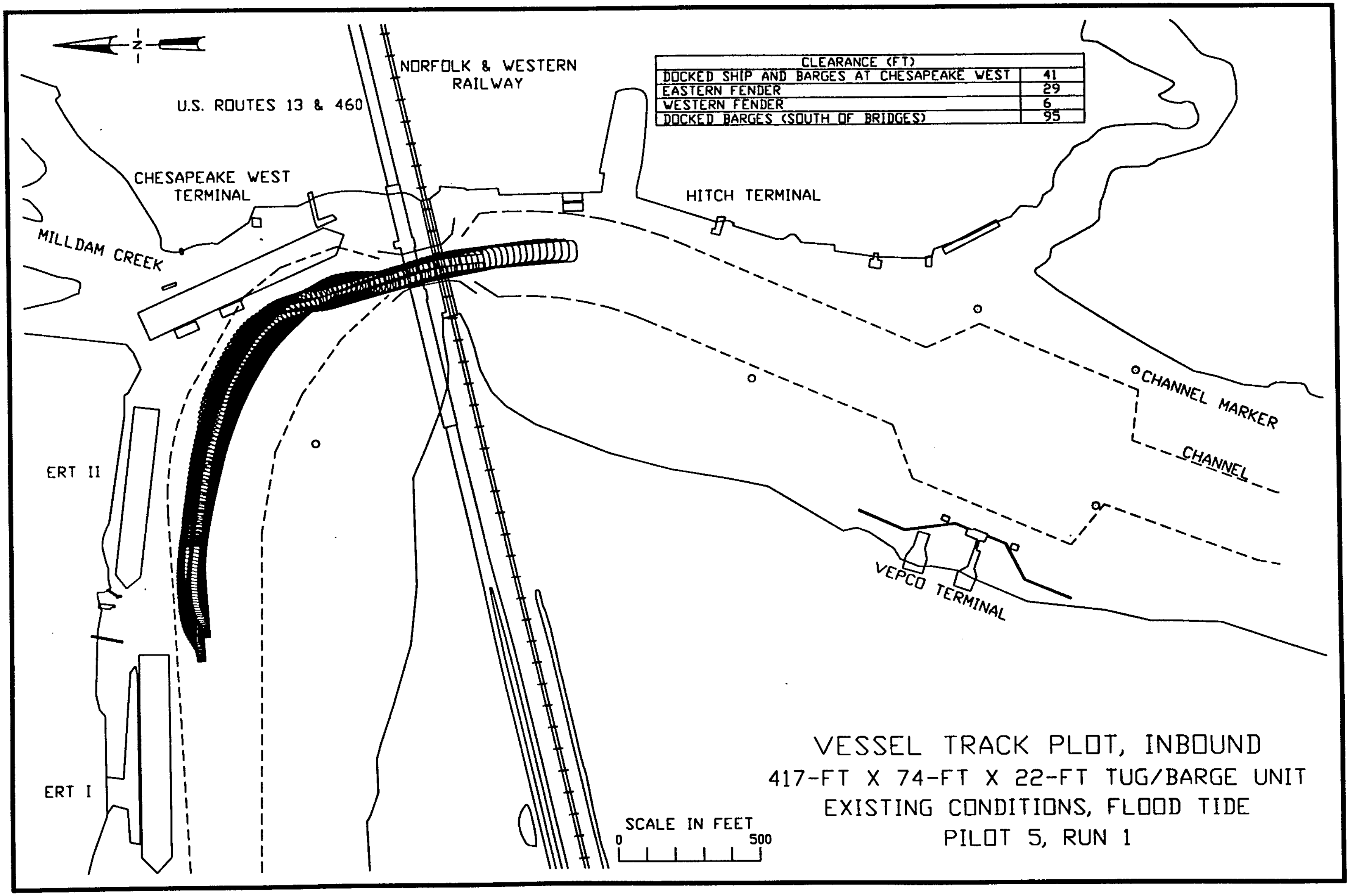

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 46
EASTERN FENDER 1
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 138
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 48



VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 5, RUN 1

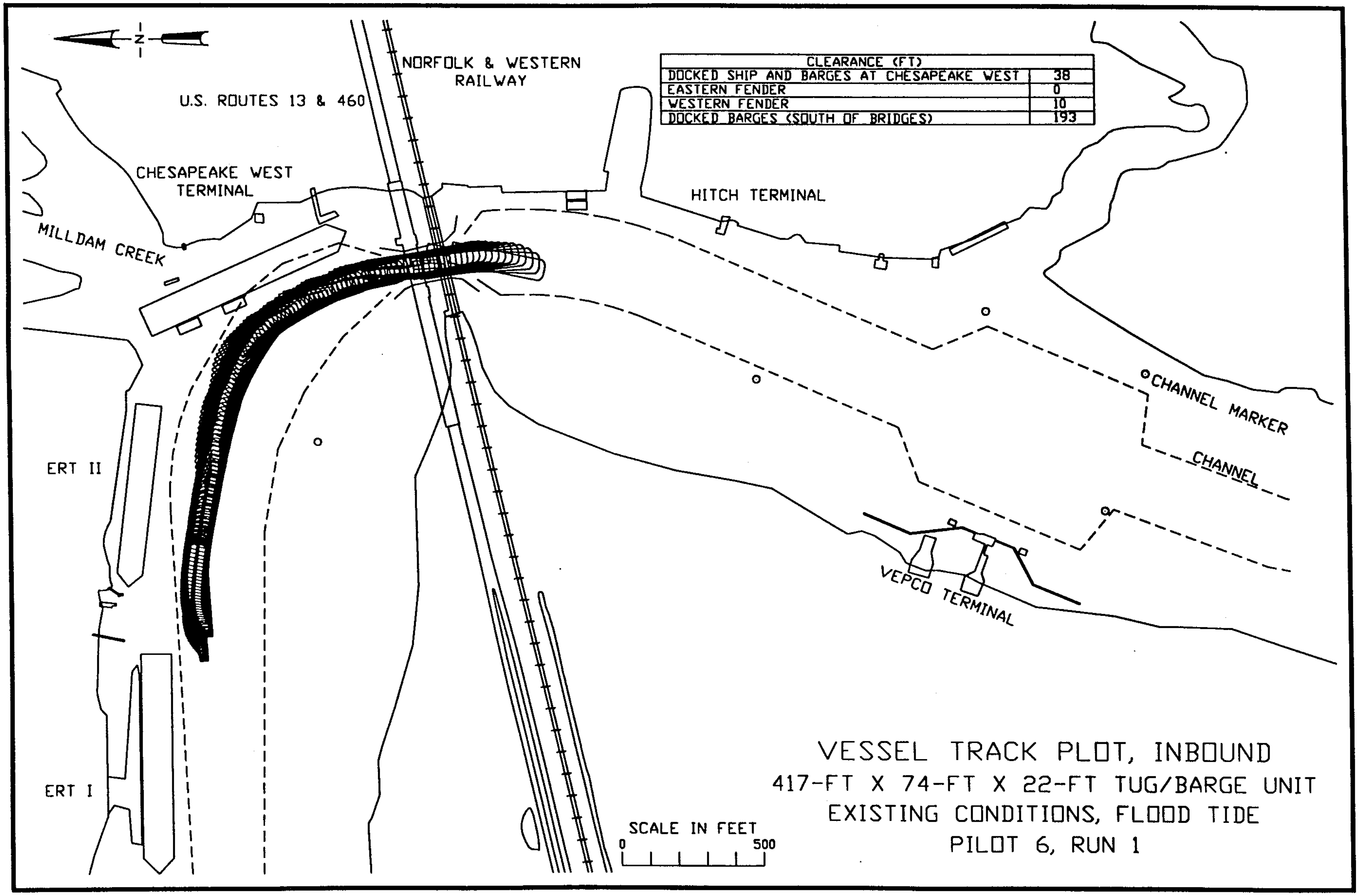
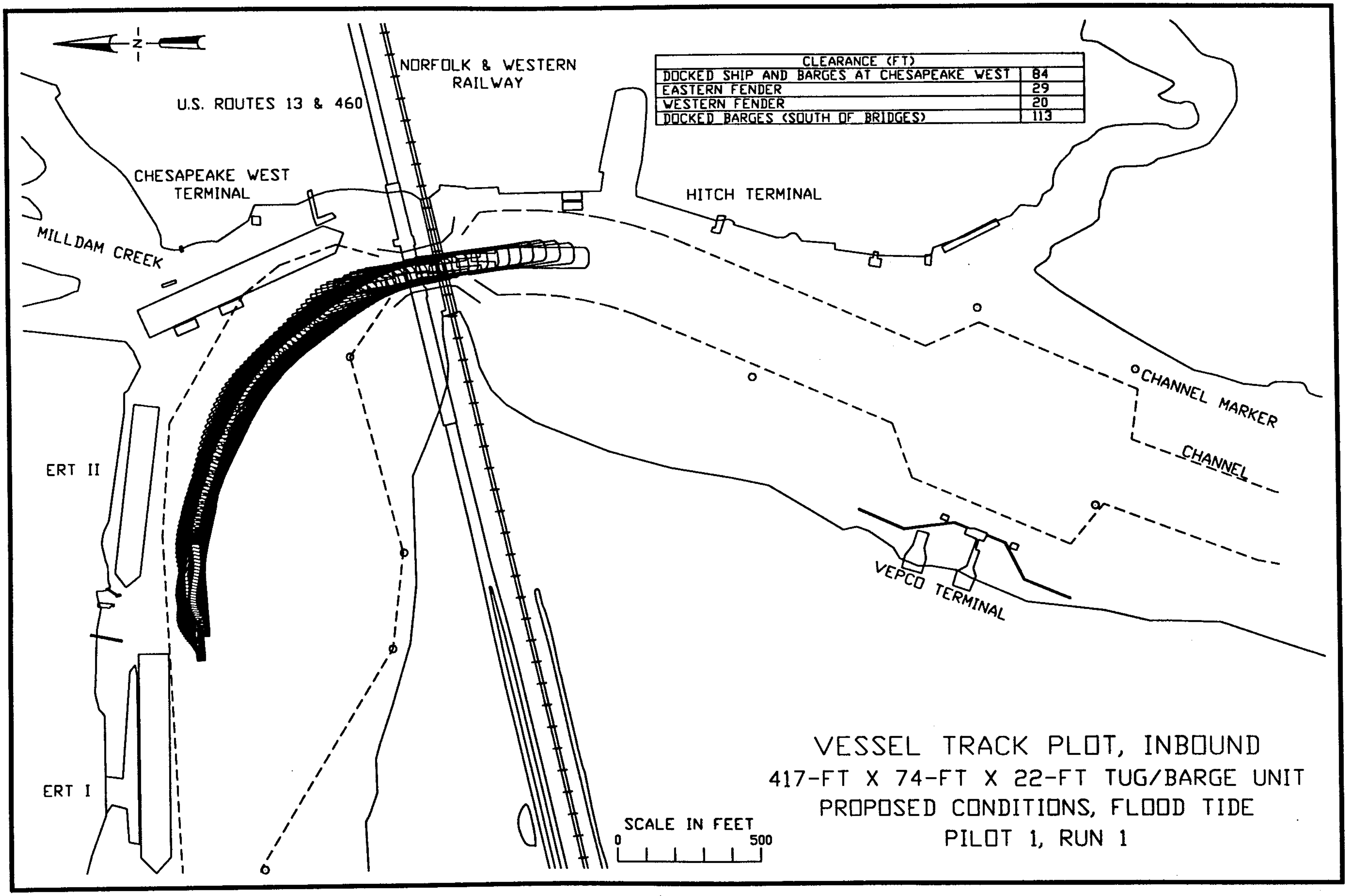

N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 38
EASTERN FENDER 0
WESTERN FENDER 10
DOCKED BARGES (SOUTH OF BRIDGES) 193
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
ERT II
ERT I
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
PILOT 6, RUN 1

Plate 50



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	84
EASTERN FENDER	29
WESTERN FENDER	20
DOCKED BARGES (SOUTH OF BRIDGES)	113

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 1, RUN 1

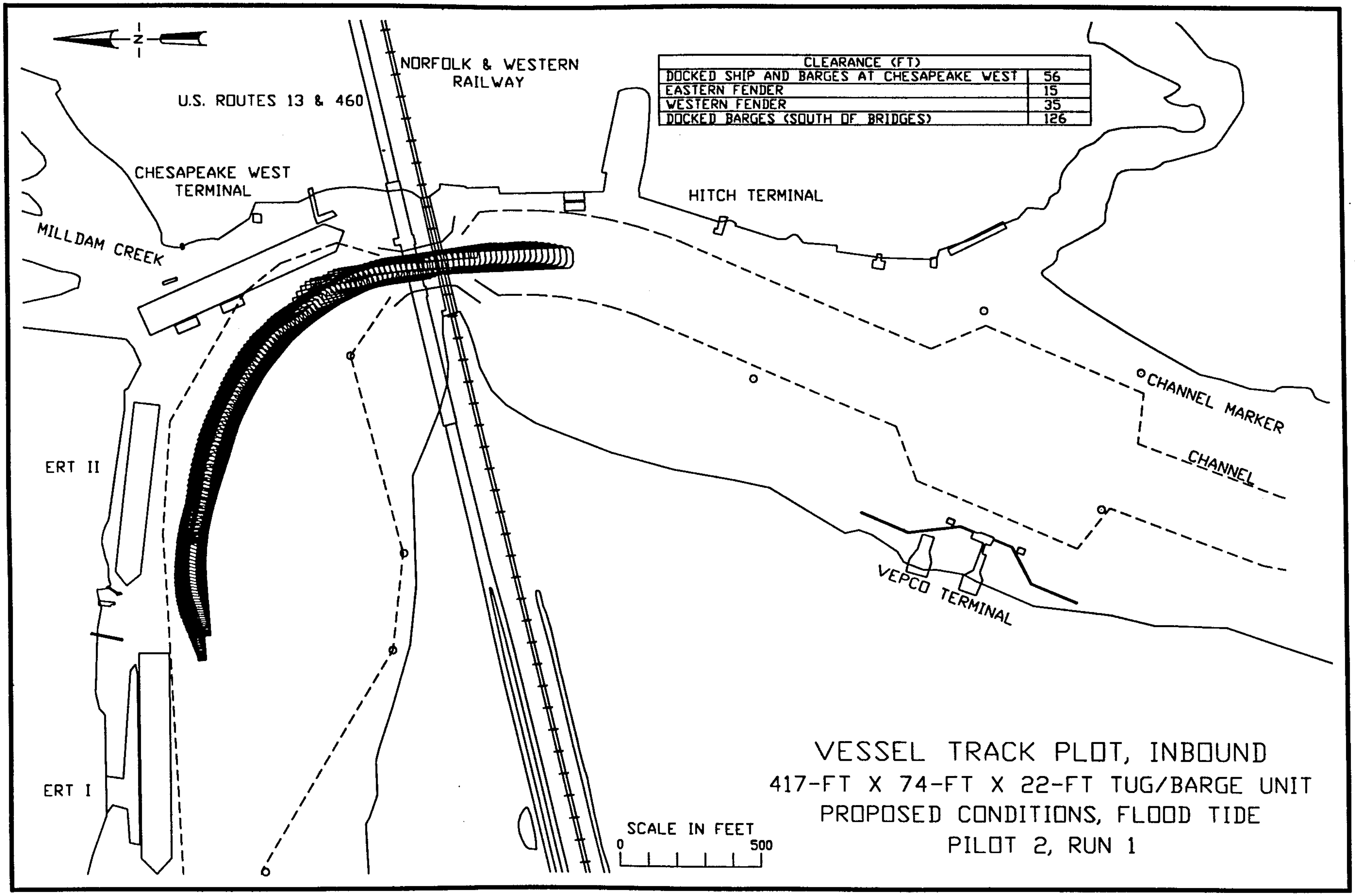
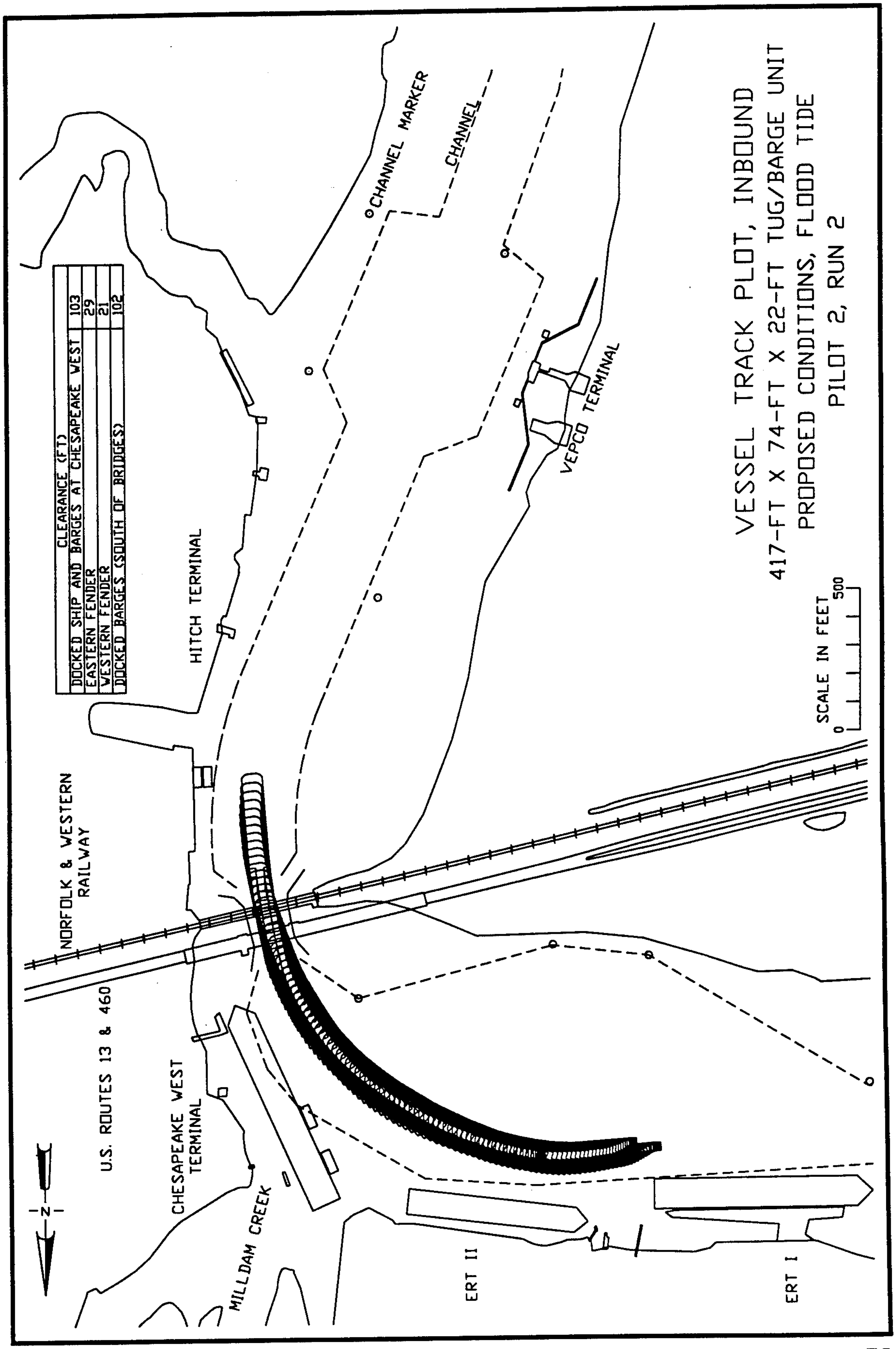

N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 56
EASTERN FENDER 15
WESTERN FENDER 35
DOCKED BARGES (SOUTH OF BRIDGES) 126
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 2, RUN 1

Plate 52



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	103
EASTERN FENDER	29
WESTERN FENDER	21
DOCKED BARGES (SOUTH OF BRIDGES)	102

Plate 53

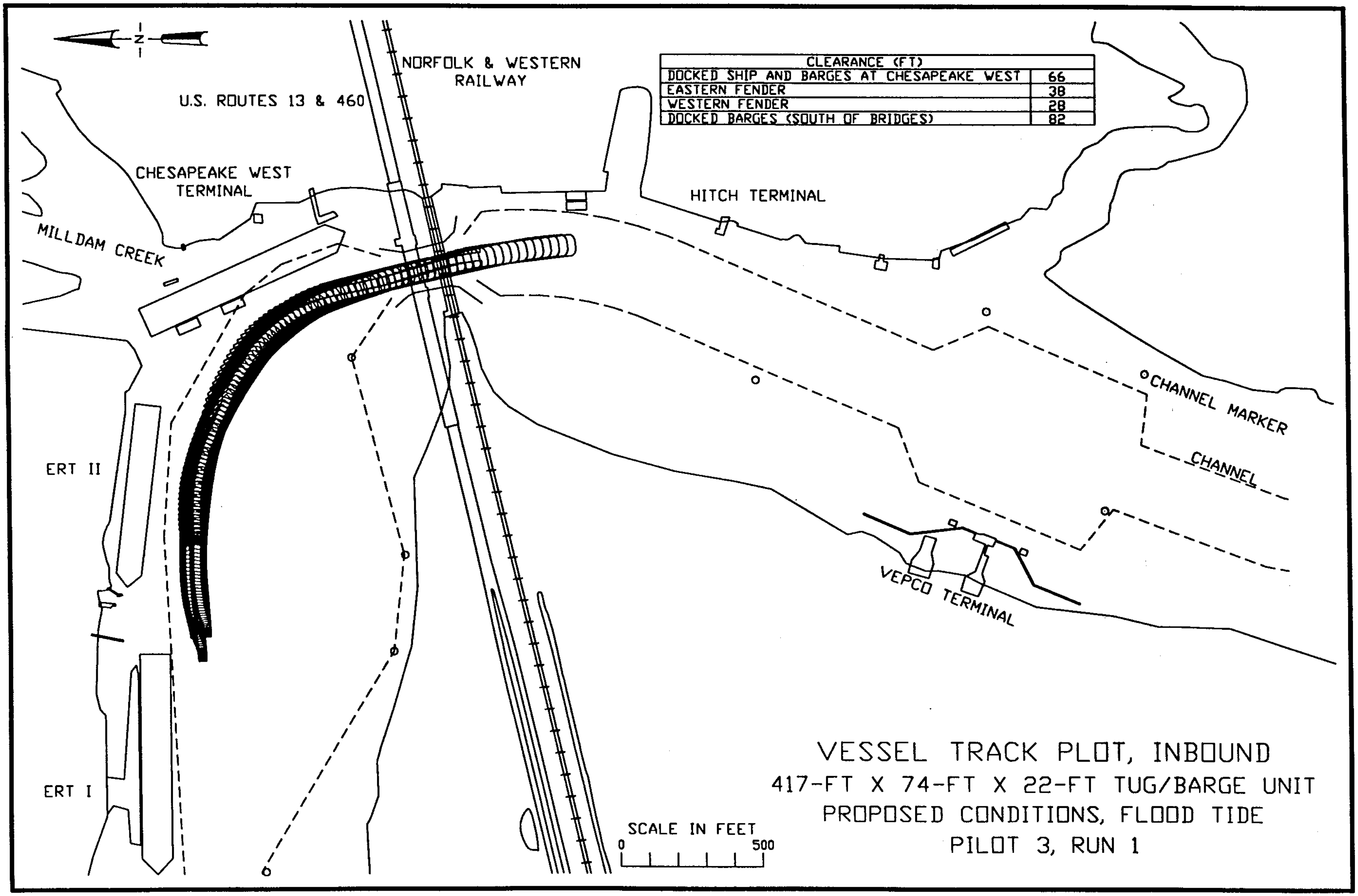
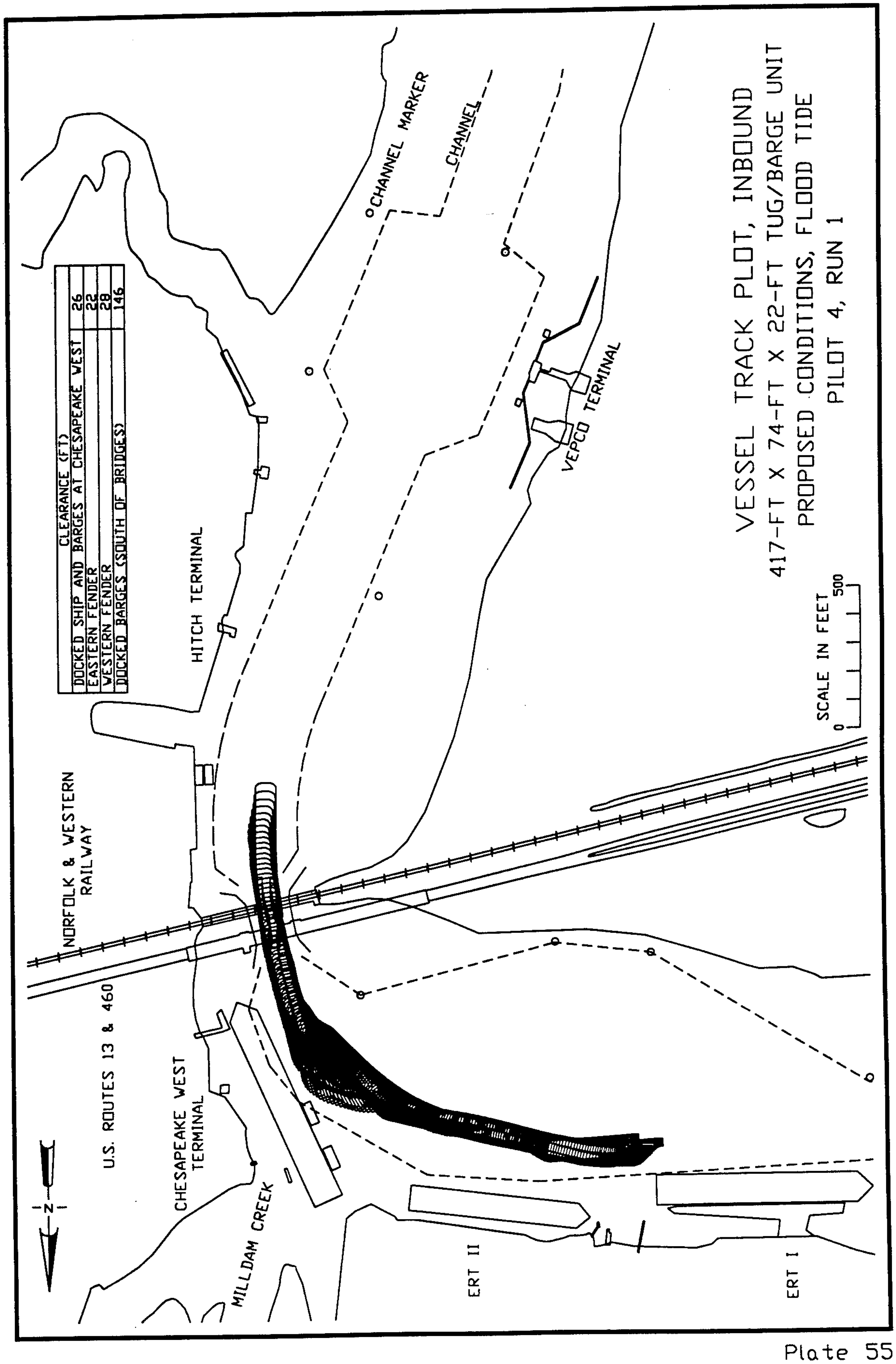

CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 66
EASTERN FENDER 38
WESTERN FENDER 28
DOCKED BARGES (SOUTH OF BRIDGES) 82
N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
HITCH TERMINAL
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
ERT II
ERT I
SCALE IN FEET
0
500
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 3, RUN 1

Plate 54


VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 26
EASTERN FENDER 22
WESTERN FENDER 28
DOCKED BARGES (SOUTH OF BRIDGES) 146
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

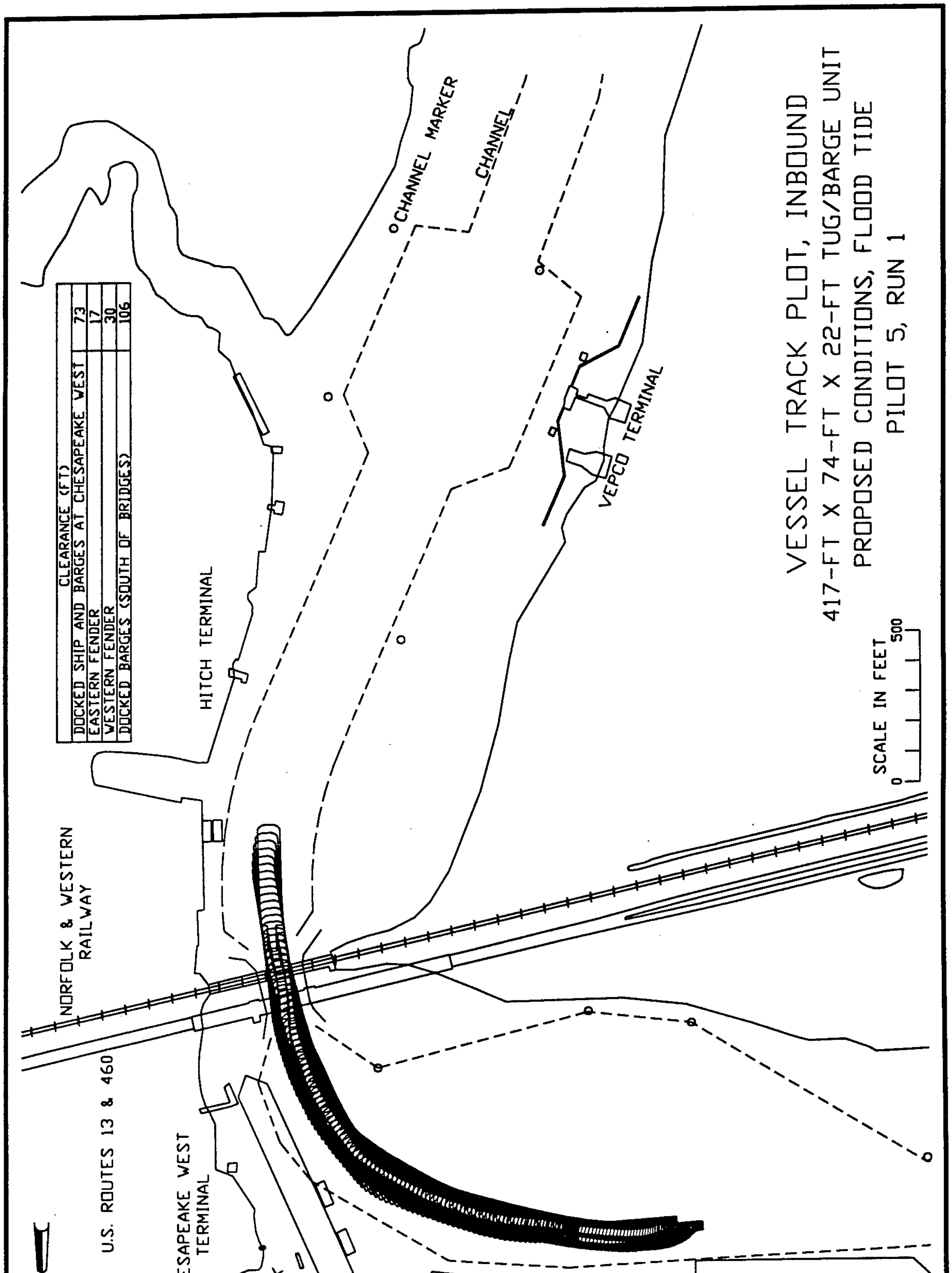
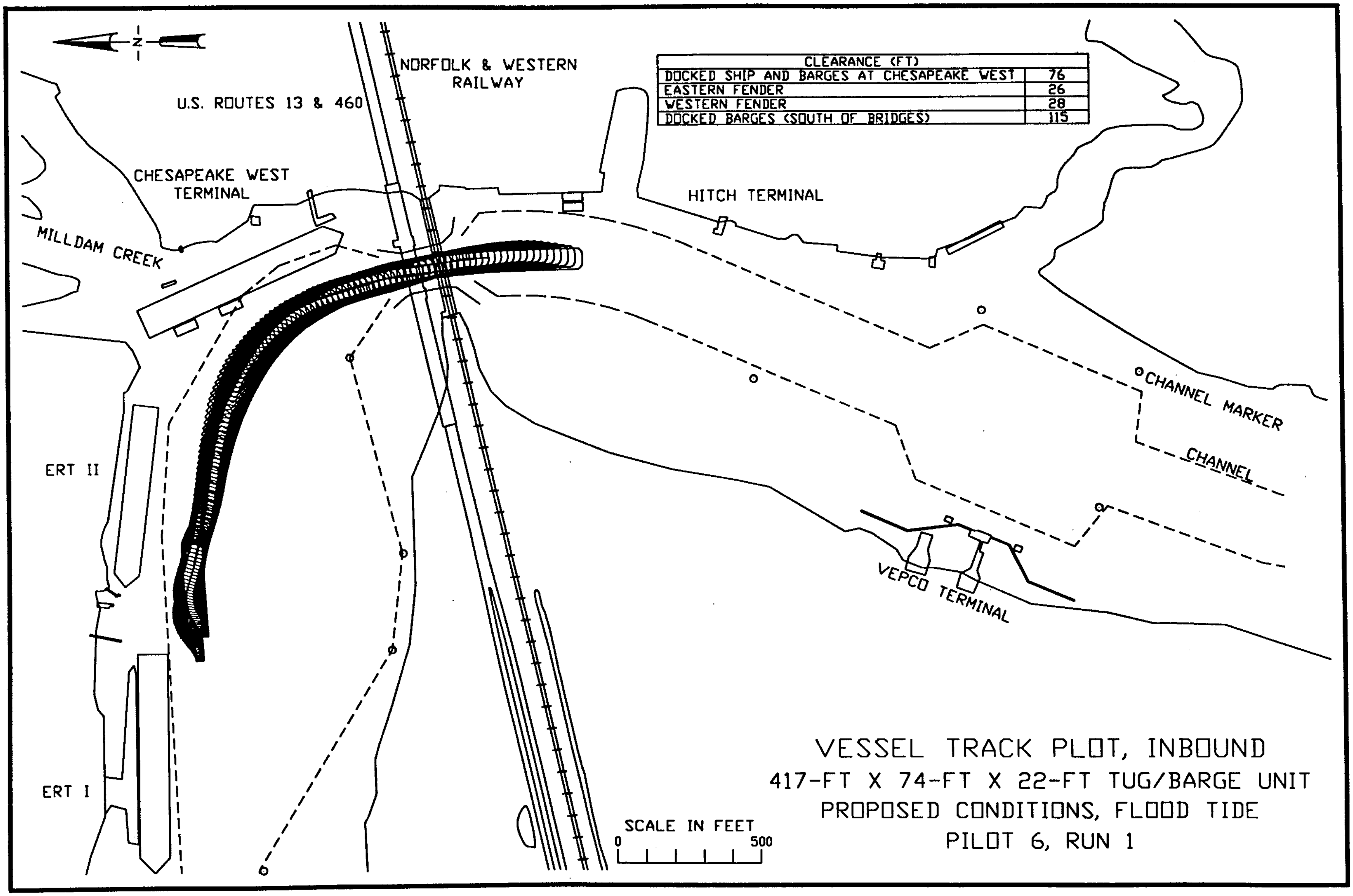
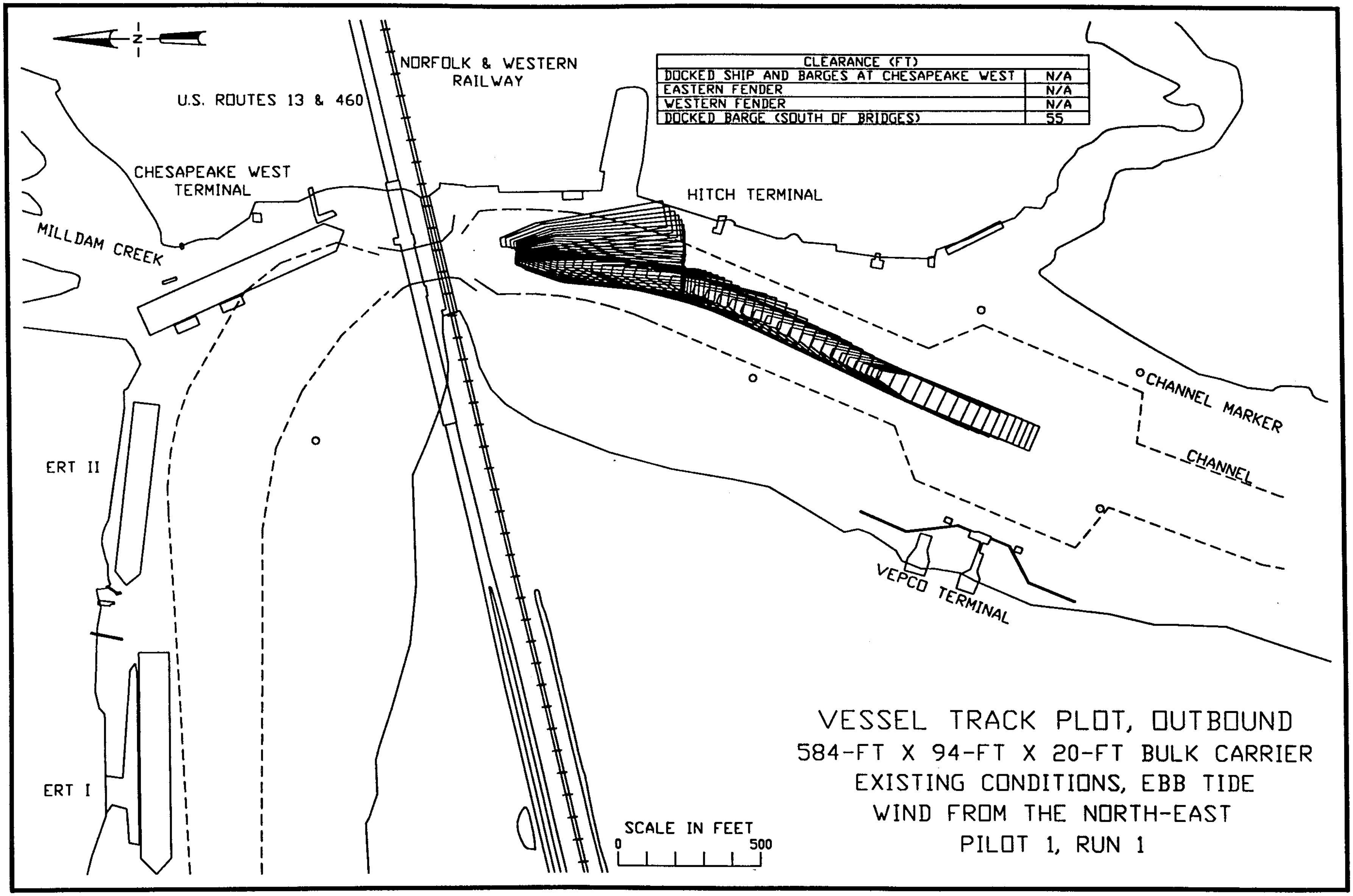

VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 73
EASTERN FENDER 17
WESTERN FENDER 30
DOCKED BARGES (SOUTH OF BRIDGES) 106
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 56



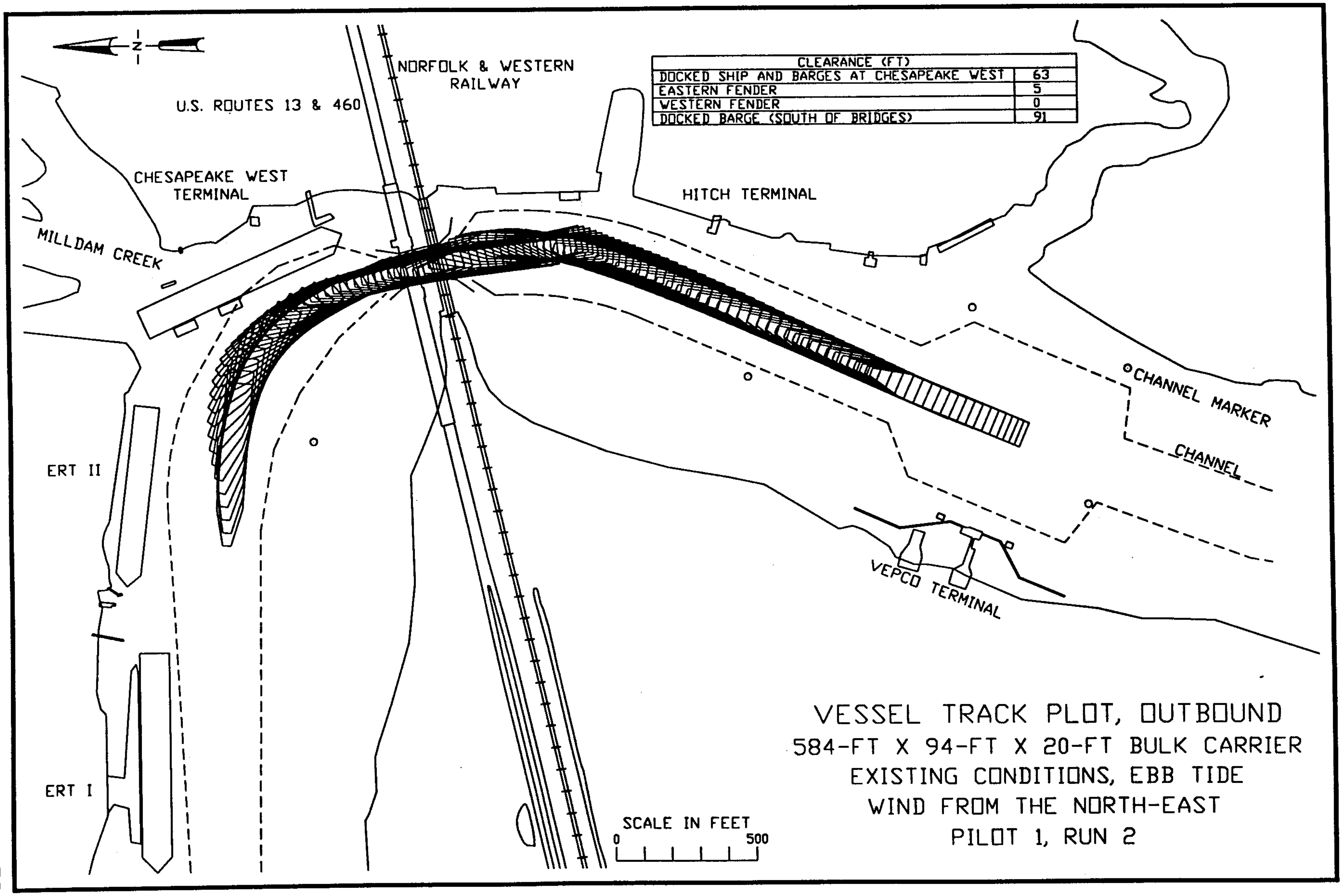
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6, RUN 1

Plate 57



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	N/A
EASTERN FENDER	N/A
WESTERN FENDER	N/A
DOCKED BARGE (SOUTH OF BRIDGES)	55

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	63
EASTERN FENDER	5
WESTERN FENDER	0
DOCKED BARGE (SOUTH OF BRIDGES)	91

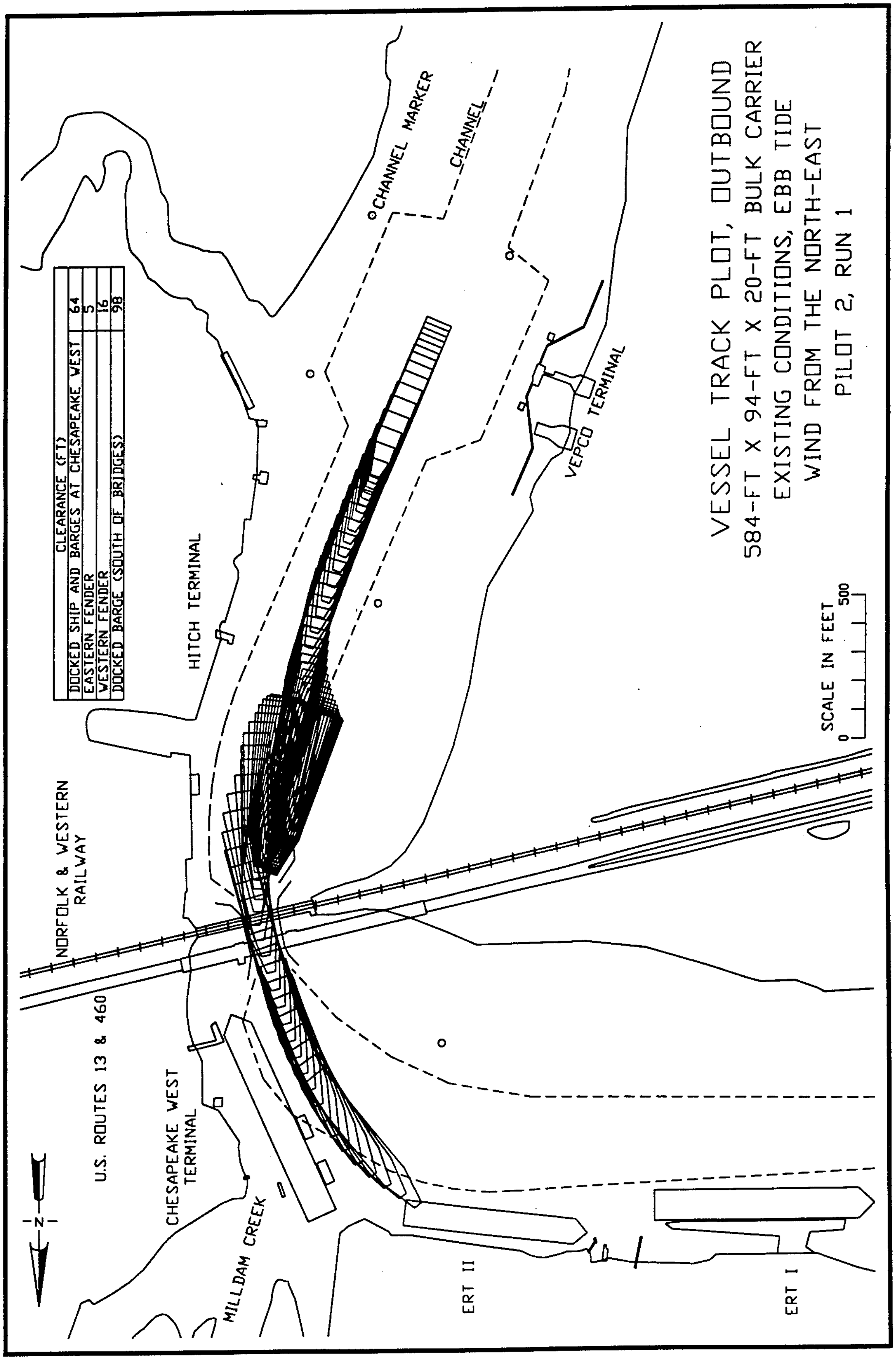

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 64
EASTERN FENDER 5
WESTERN FENDER 16
DOCKED BARGE (SOUTH OF BRIDGES) 98
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 60

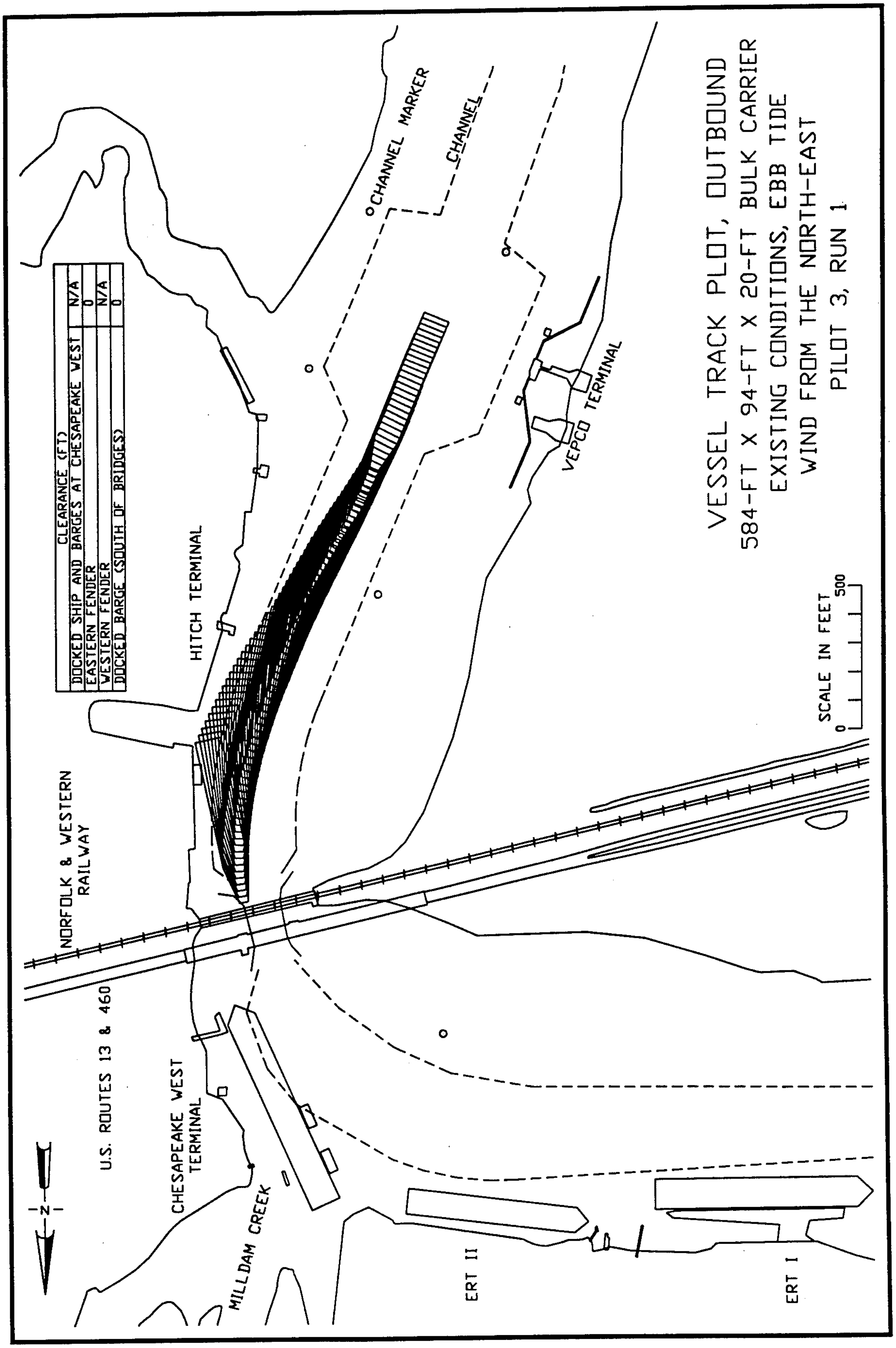

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST N/A
EASTERN FENDER 0
WESTERN FENDER N/A
DOCKED BARGE (SOUTH OF BRIDGES) 0
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 61

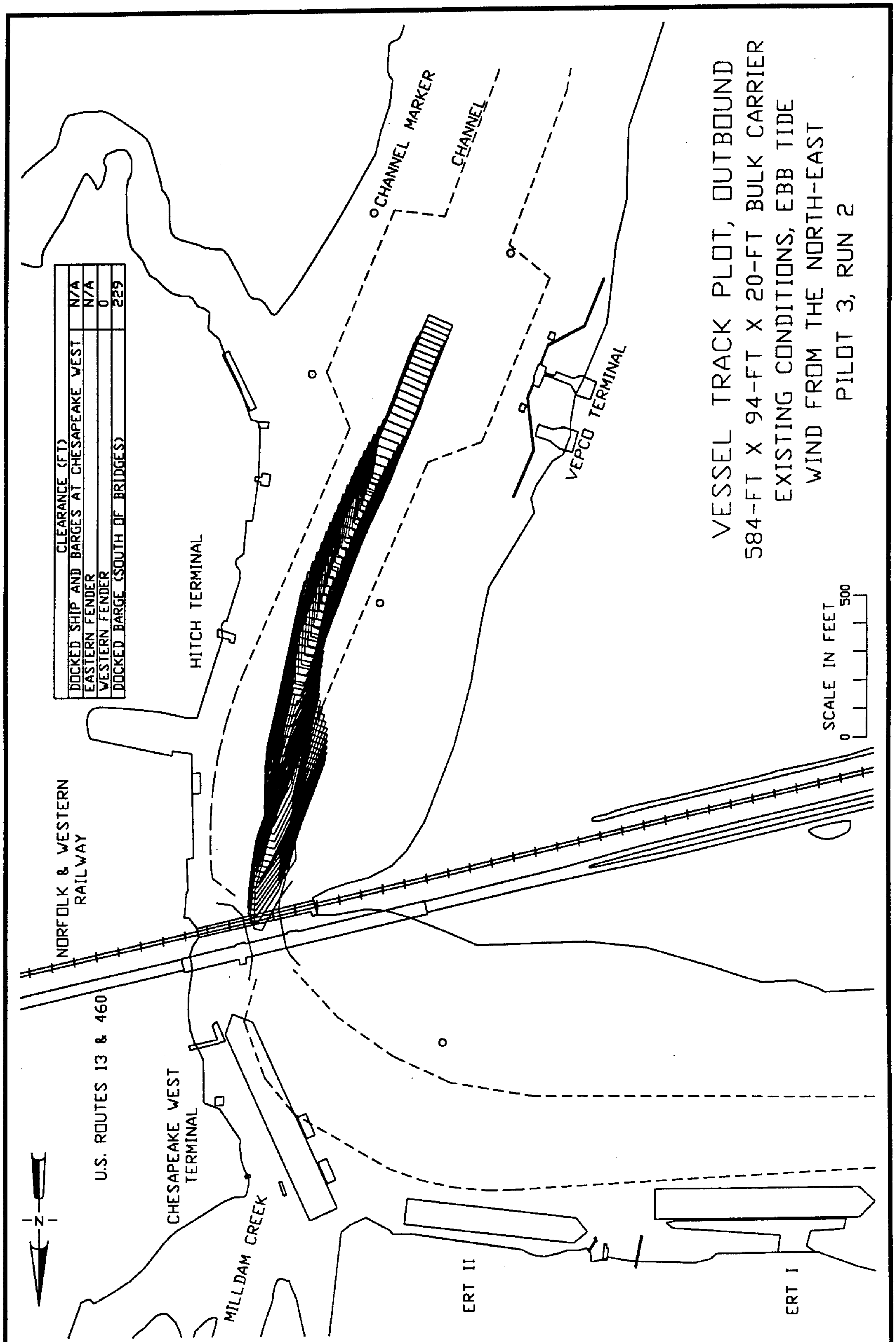

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST N/A
EASTERN FENDER N/A
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 229
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 62

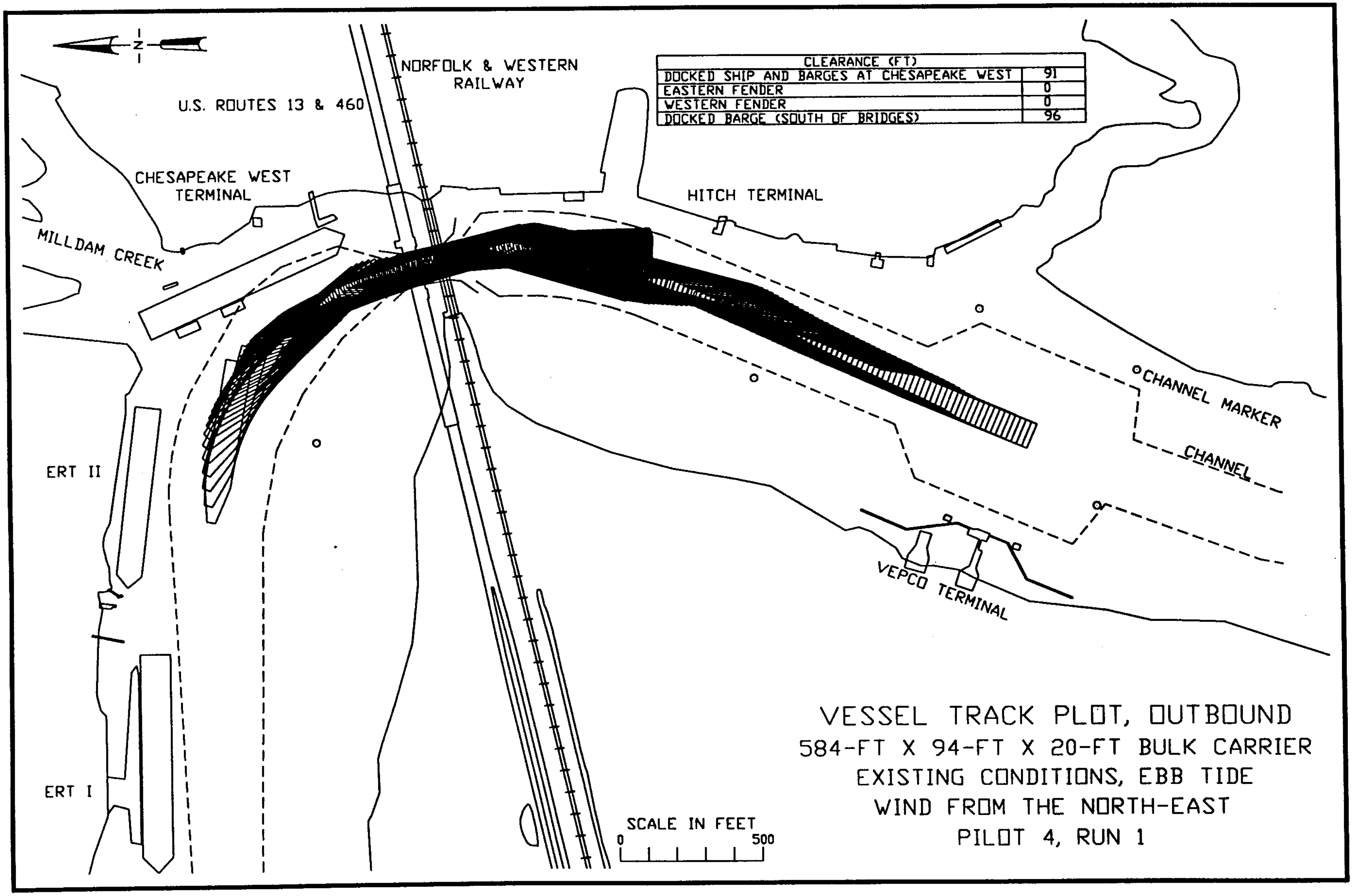

N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
HITCH TERMINAL
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 91
EASTERN FENDER 0
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 96
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
ERT II
ERT I
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1

Plate 63

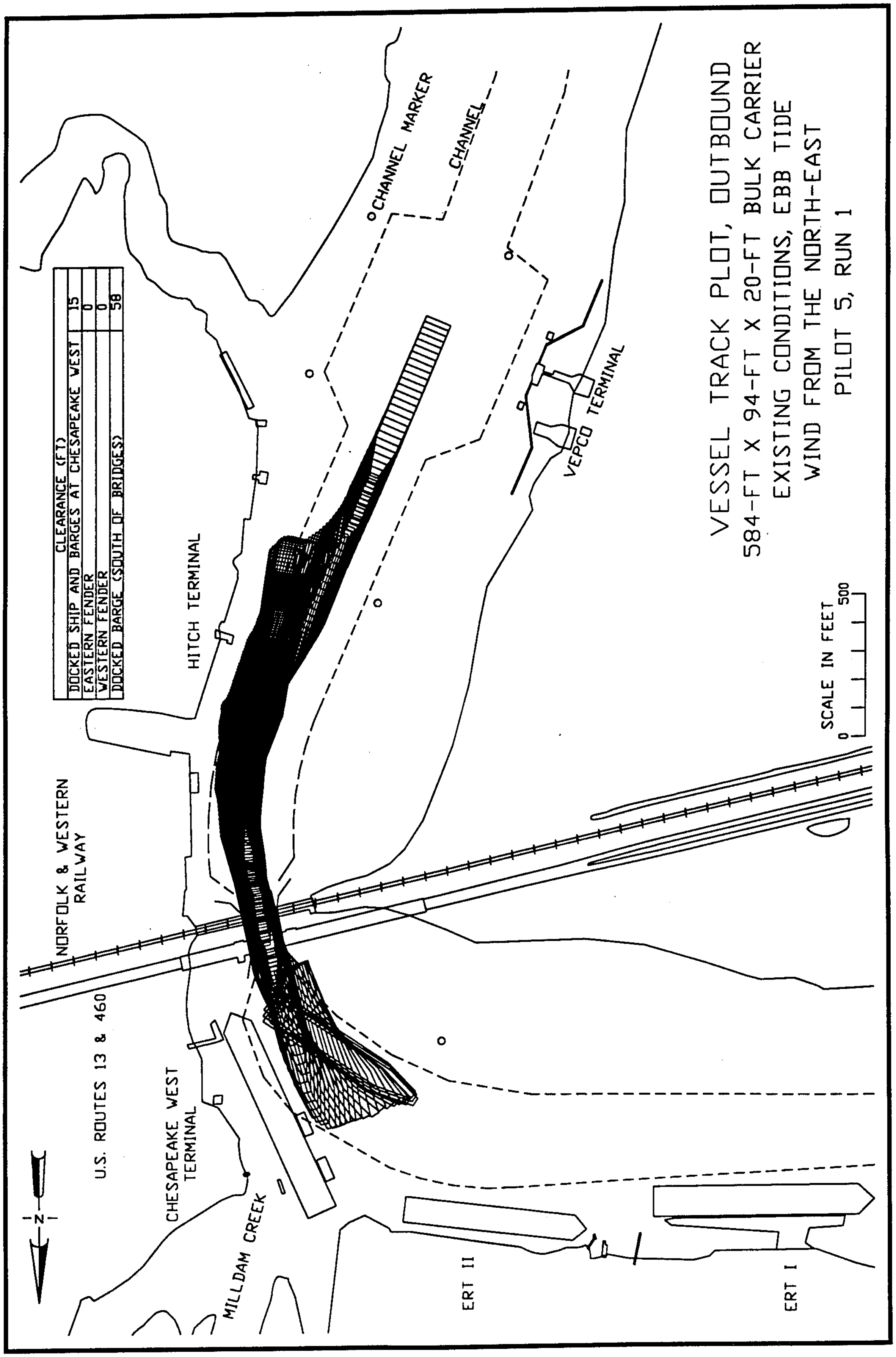
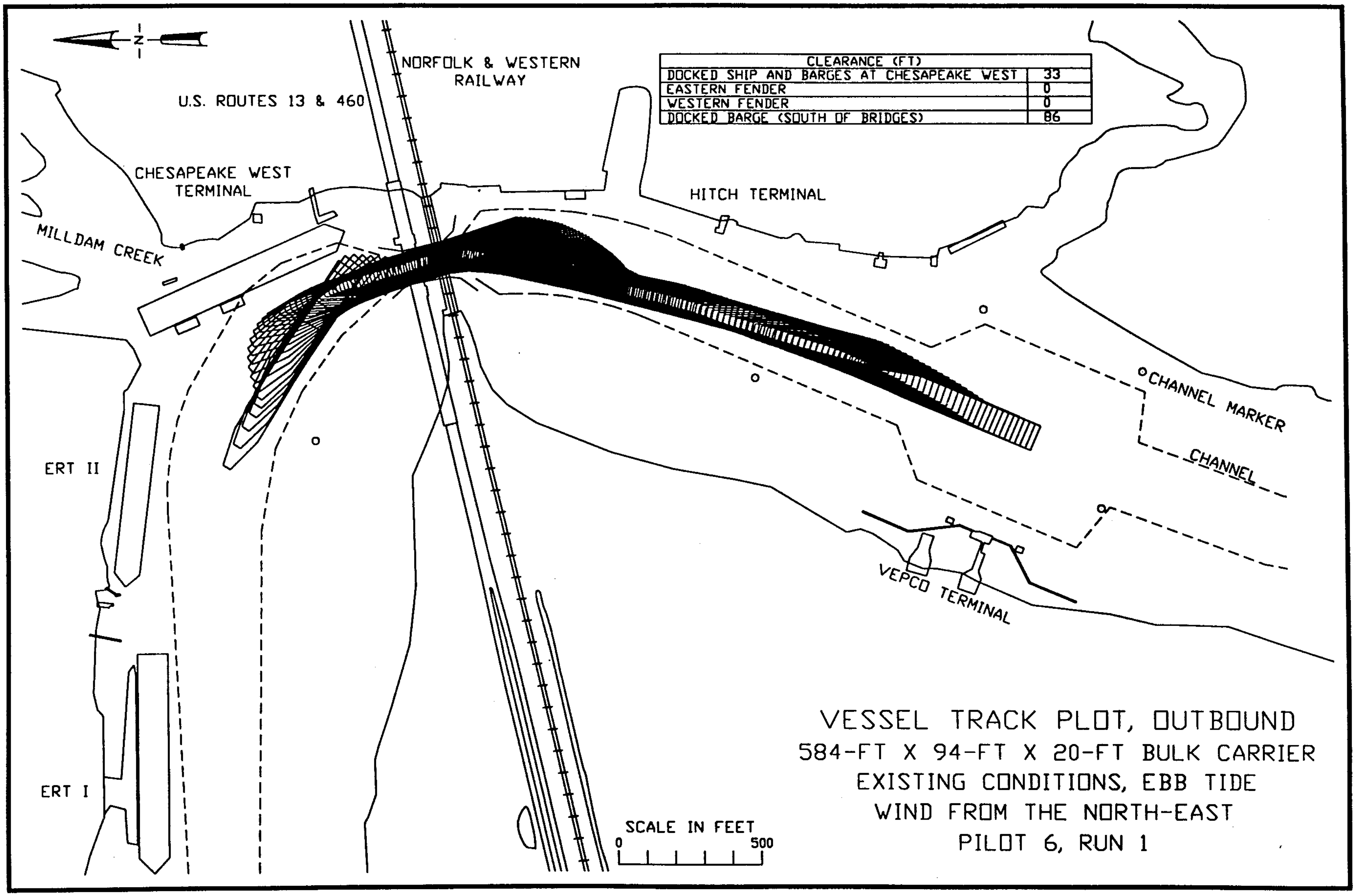

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 15
EASTERN FENDER 0
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 58
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 64



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	33
EASTERN FENDER	0
WESTERN FENDER	0
DOCKED BARGE (SOUTH OF BRIDGES)	86

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1

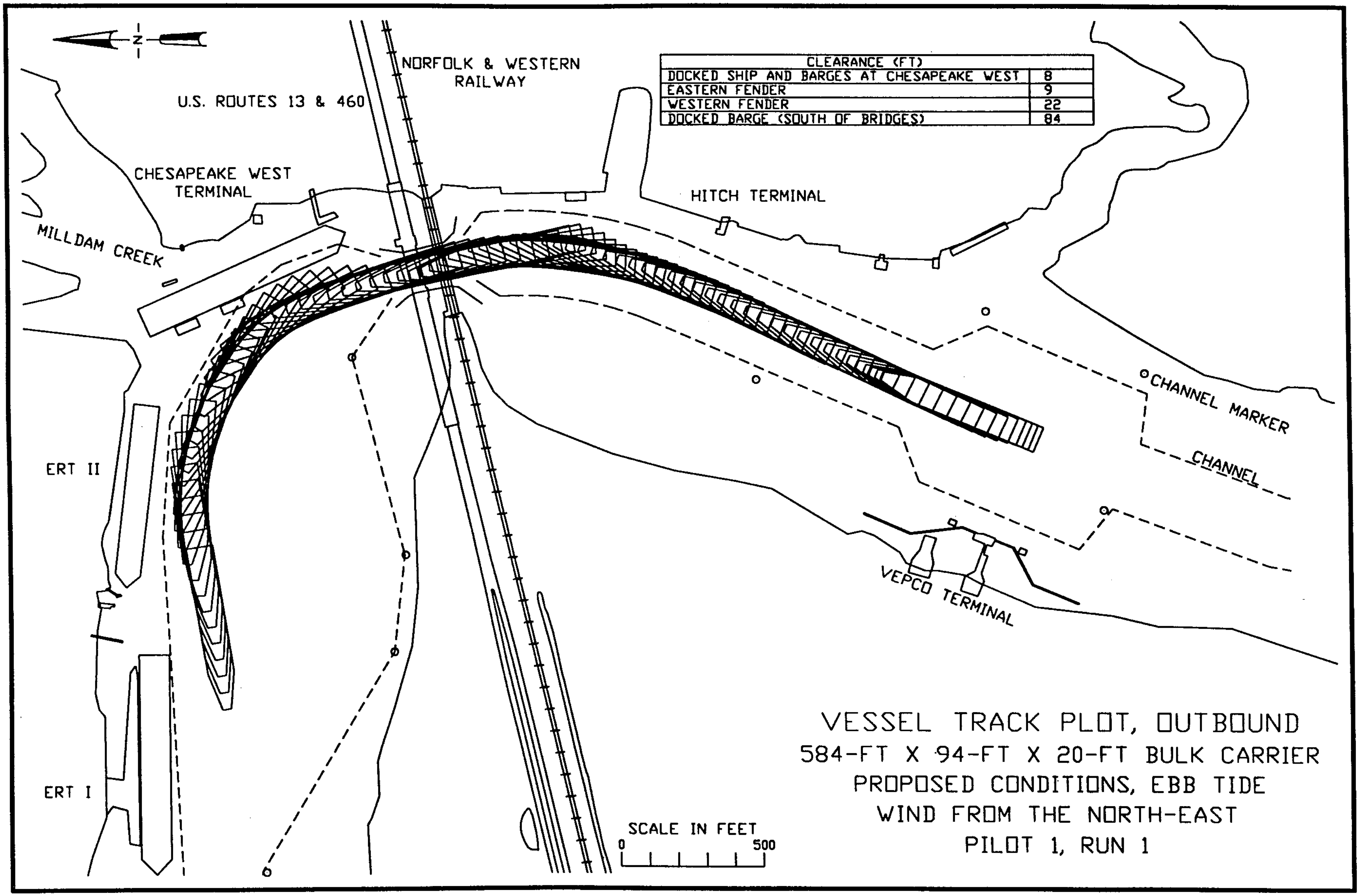
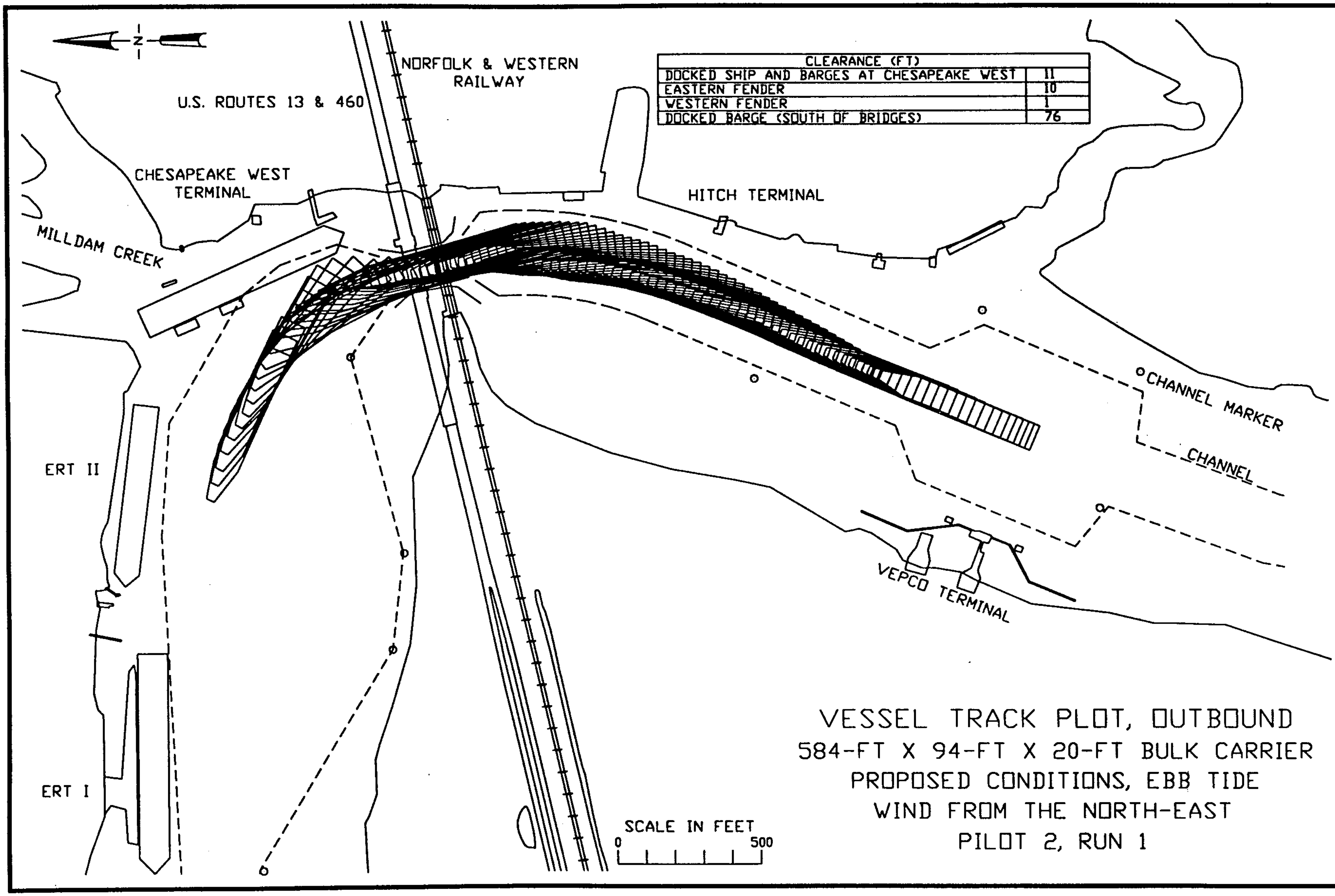

N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 8
EASTERN FENDER 9
WESTERN FENDER 22
DOCKED BARGE (SOUTH OF BRIDGES) 84
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1
SCALE IN FEET
0
500

Plate 66



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	11
EASTERN FENDER	10
WESTERN FENDER	1
DOCKED BARGE (SOUTH OF BRIDGES)	76

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1

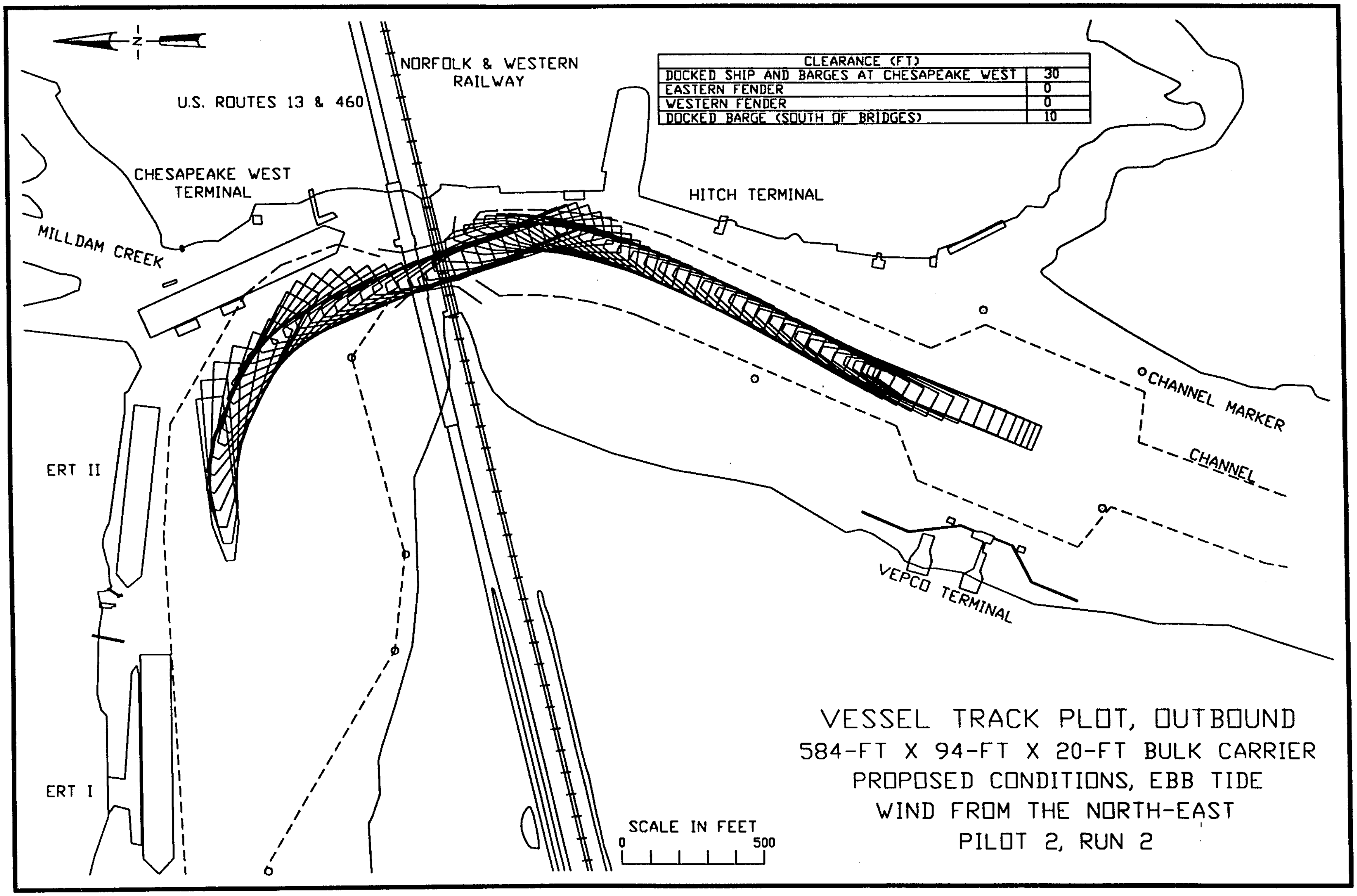

N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 30
EASTERN FENDER 0
WESTERN FENDER 0
DOCKED BARGE (SOUTH OF BRIDGES) 10
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 2

Plate 68

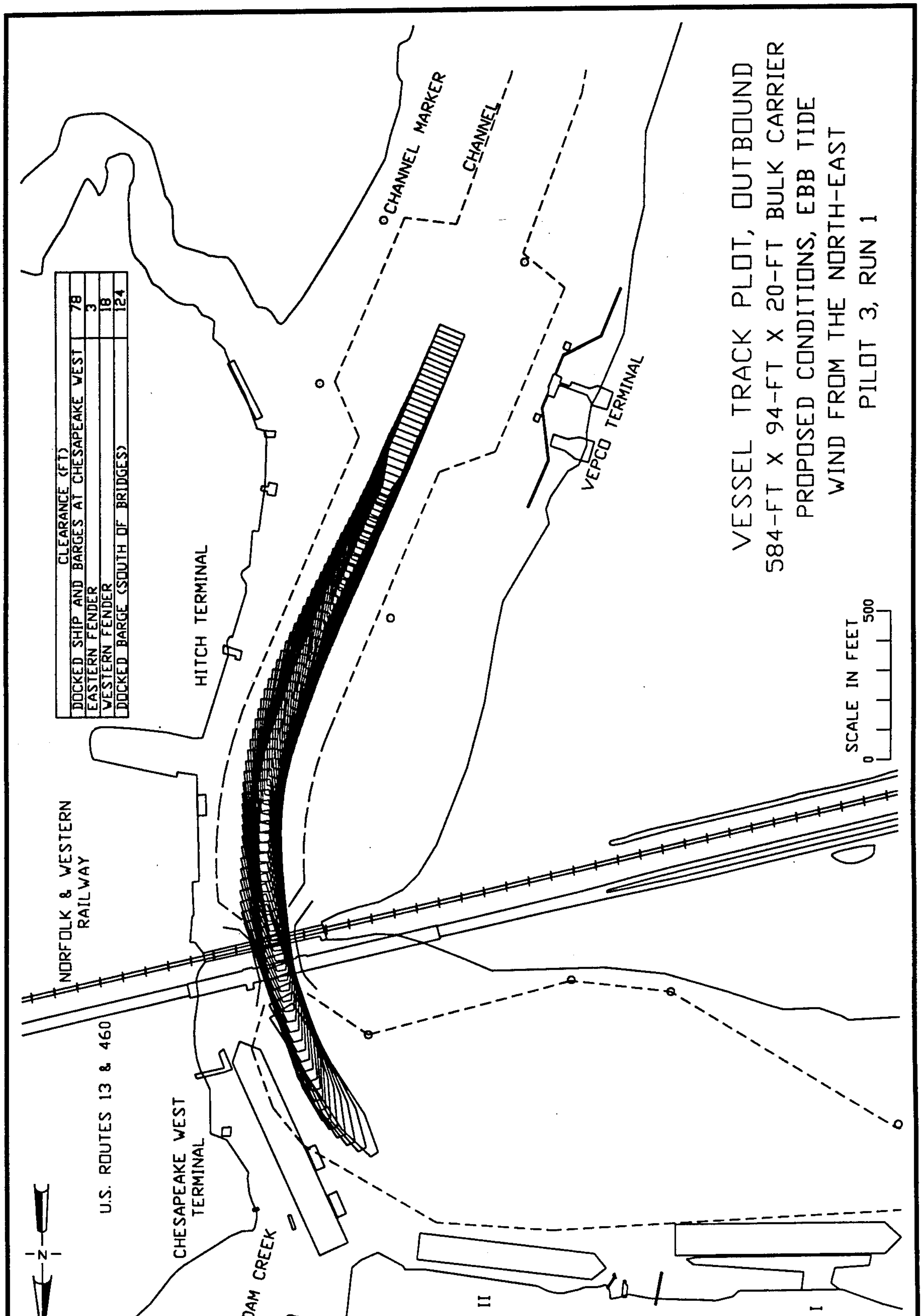

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 78
EASTERN FENDER 3
WESTERN FENDER 18
DOCKED BARGE (SOUTH OF BRIDGES) 124
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 69

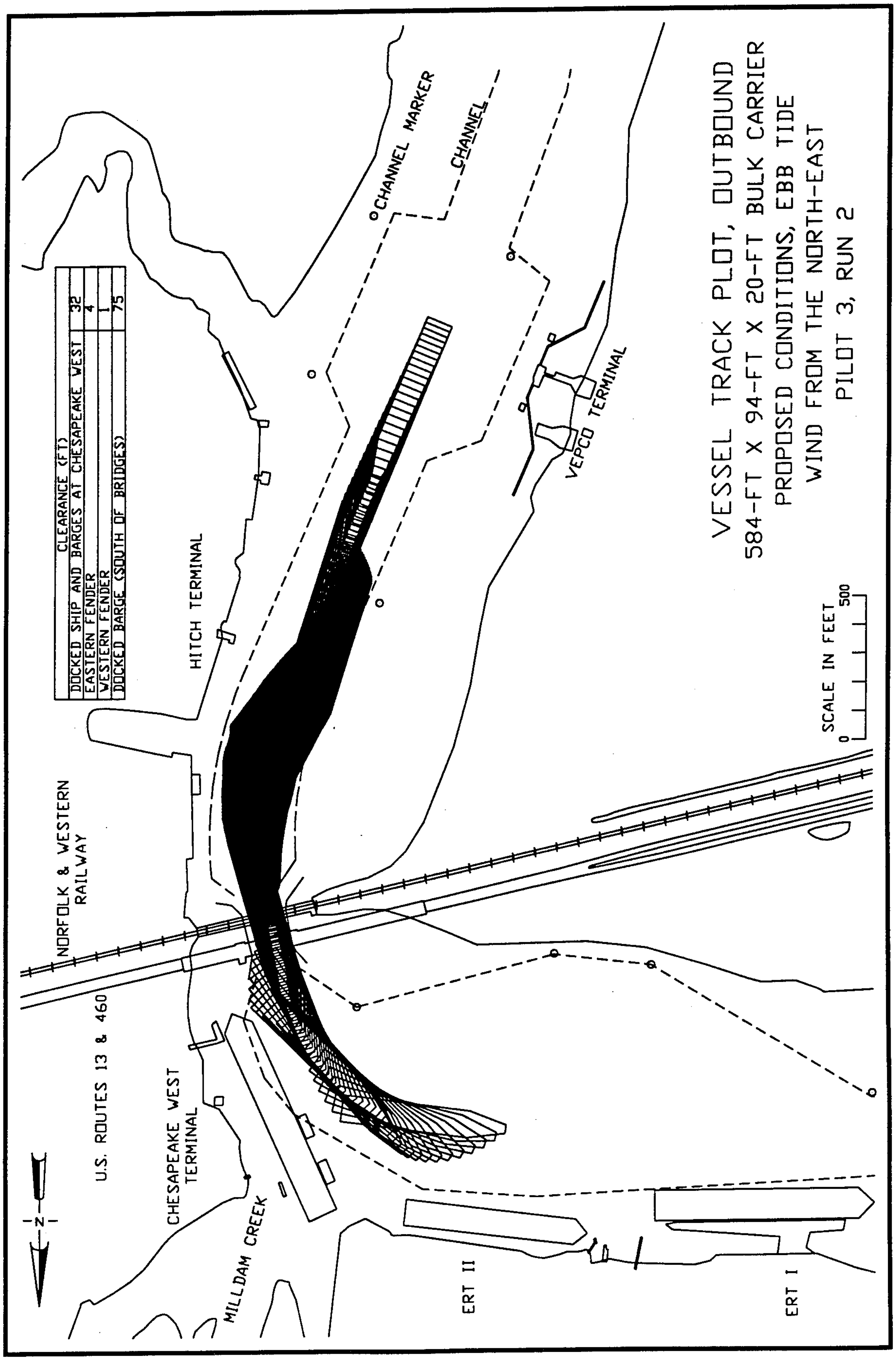
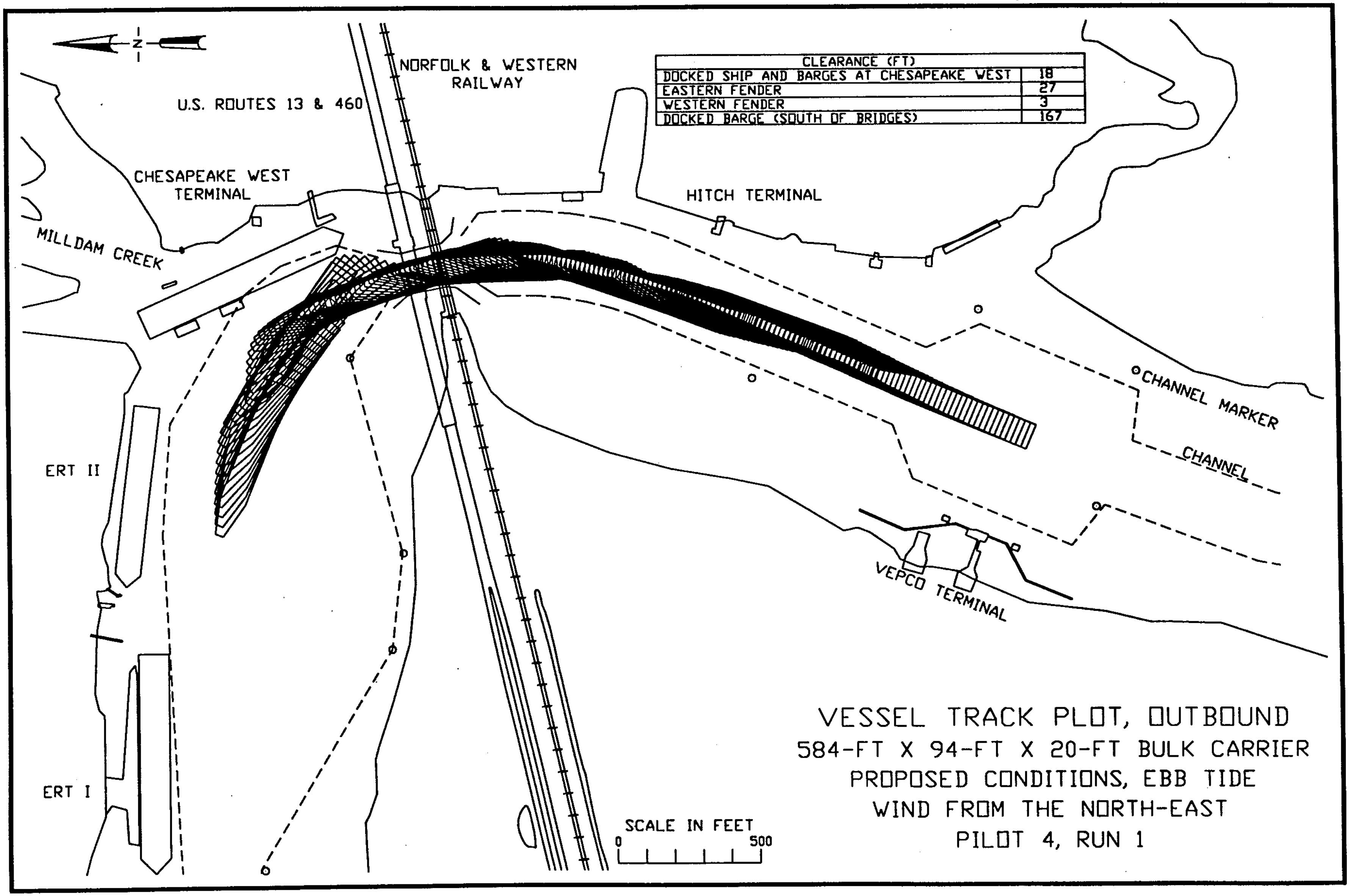

VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 32
EASTERN FENDER 4
WESTERN FENDER 1
DOCKED BARGE (SOUTH OF BRIDGES) 75
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 70


N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 18
EASTERN FENDER 27
WESTERN FENDER 3
DOCKED BARGE (SOUTH OF BRIDGES) 167
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
ERT II
ERT I
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1

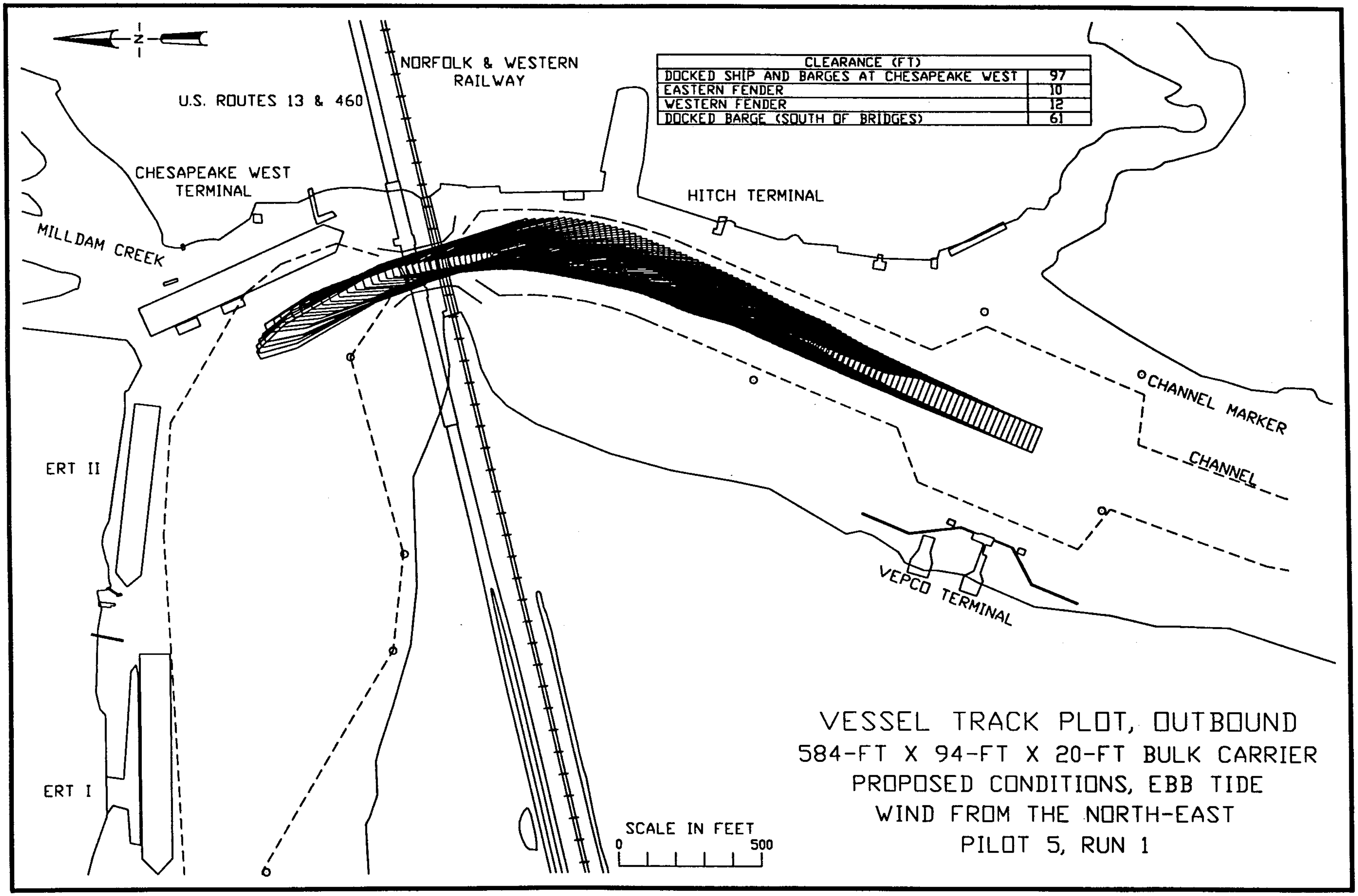
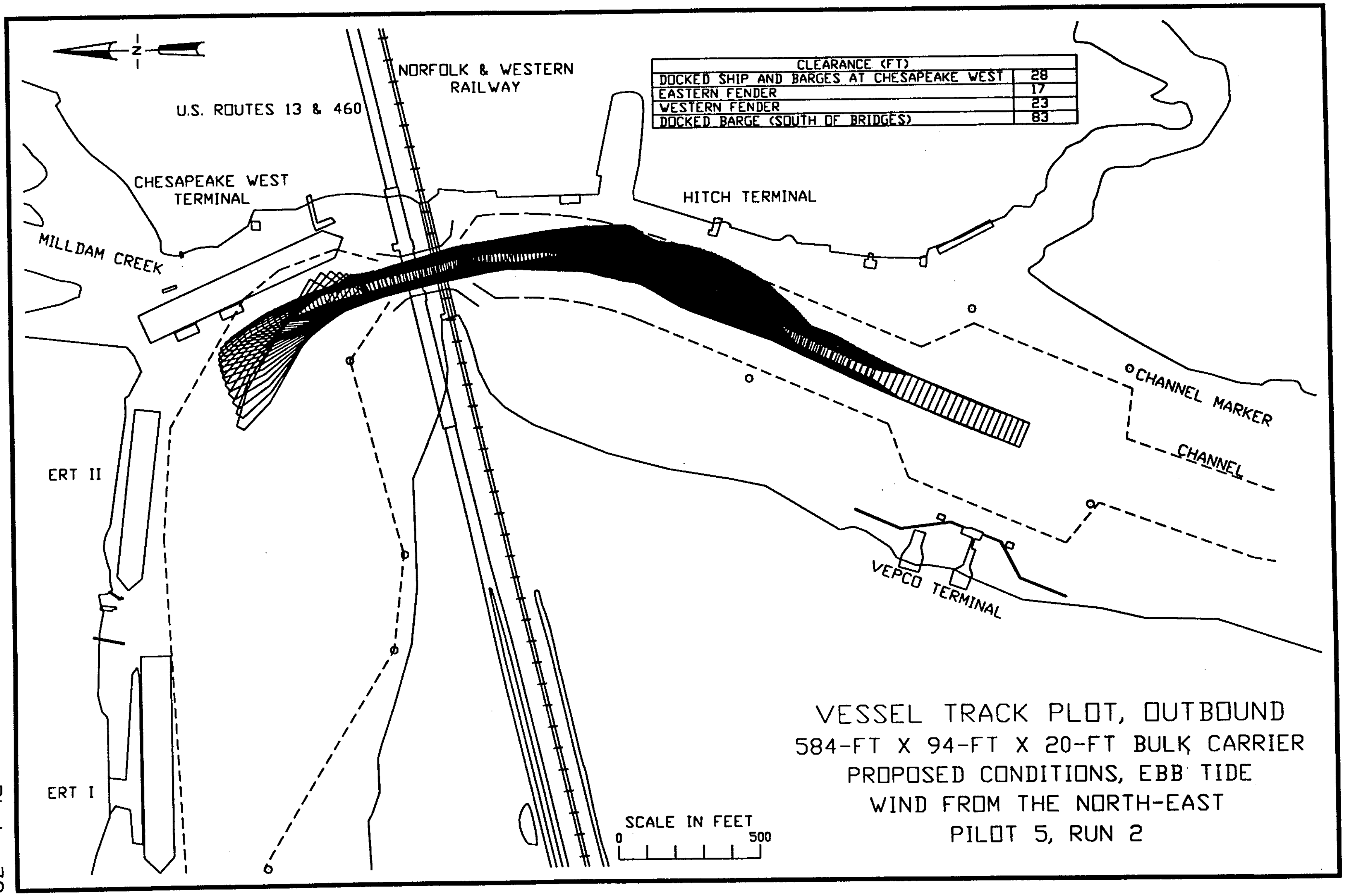

N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 97
EASTERN FENDER 10
WESTERN FENDER 12
DOCKED BARGE (SOUTH OF BRIDGES) 61
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
ERT II
ERT I
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1

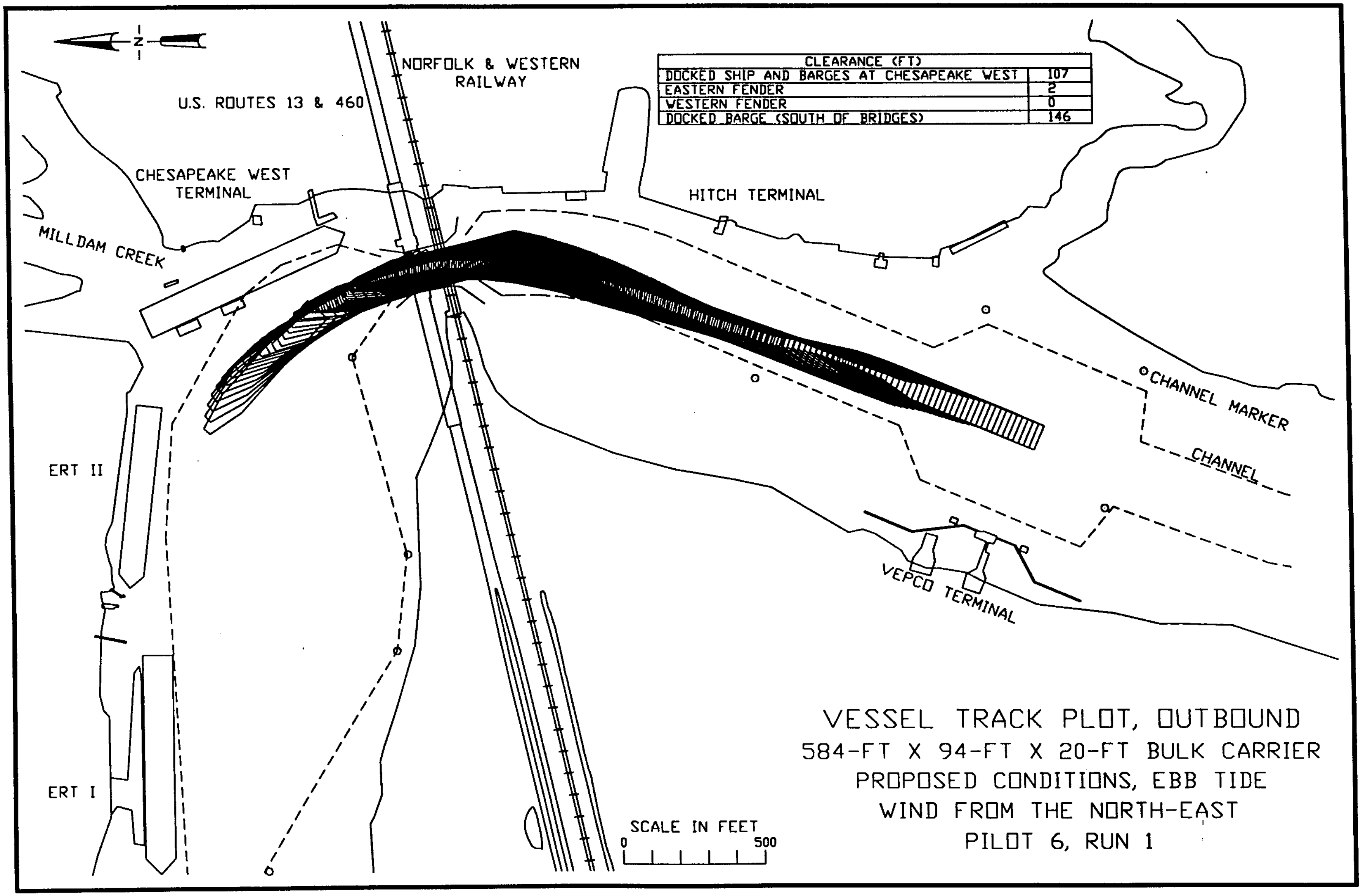
Plate 72



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	28
EASTERN FENDER	17
WESTERN FENDER	23
DOCKED BARGE (SOUTH OF BRIDGES)	83

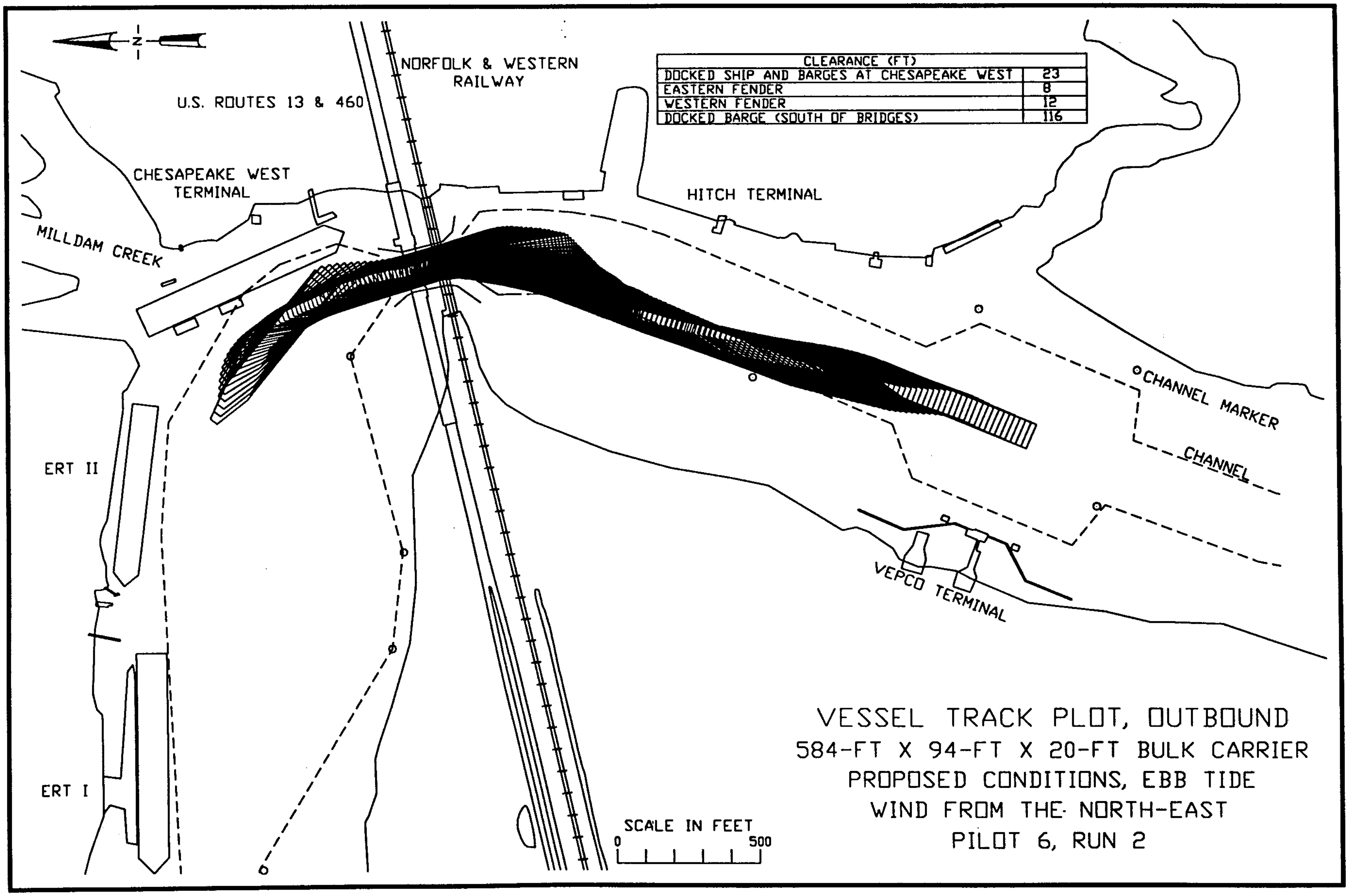
VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 2

Plate 73

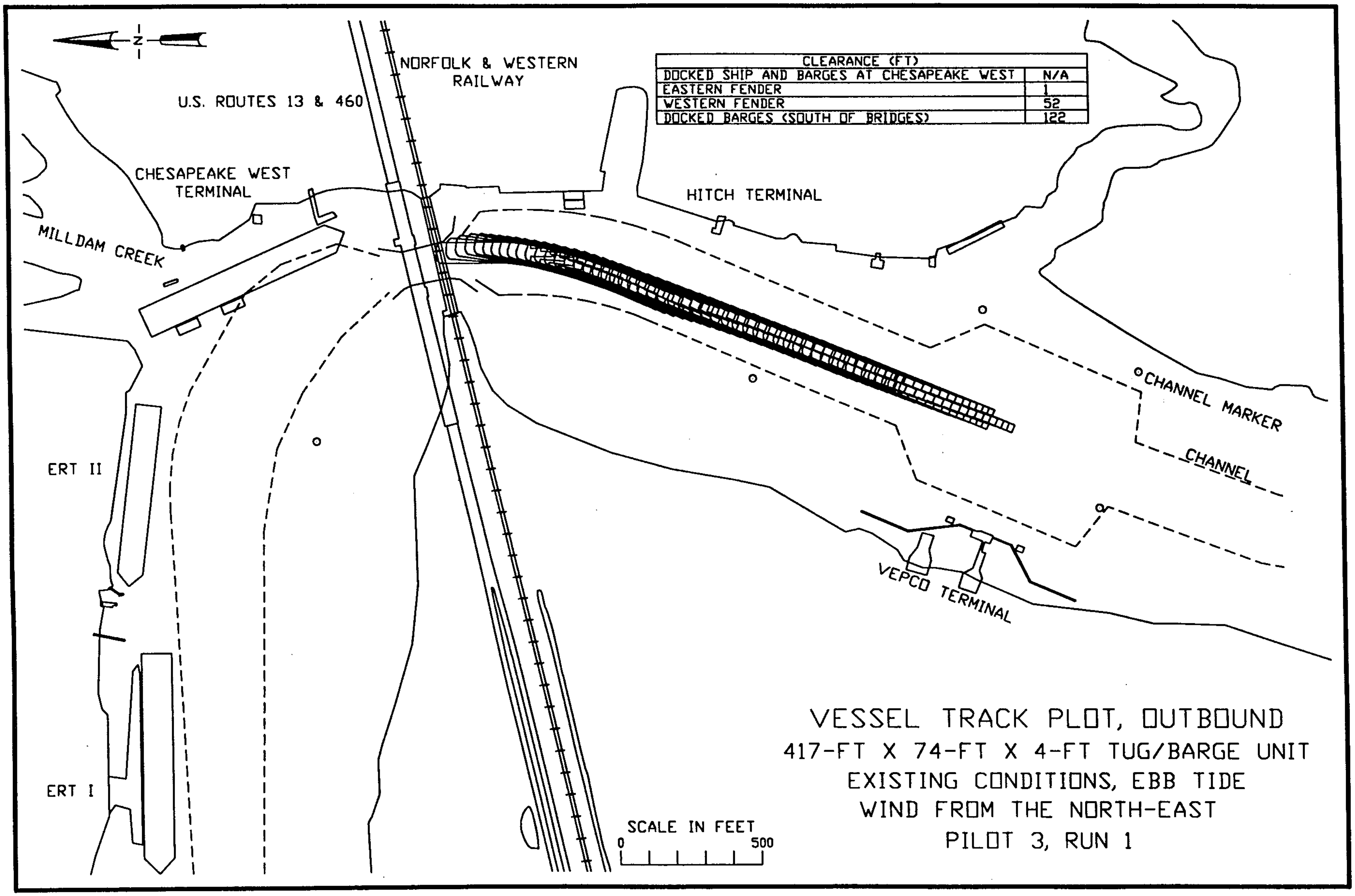


CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	107
EASTERN FENDER	2
WESTERN FENDER	0
DOCKED BARGE (SOUTH OF BRIDGES)	146

Plate 74



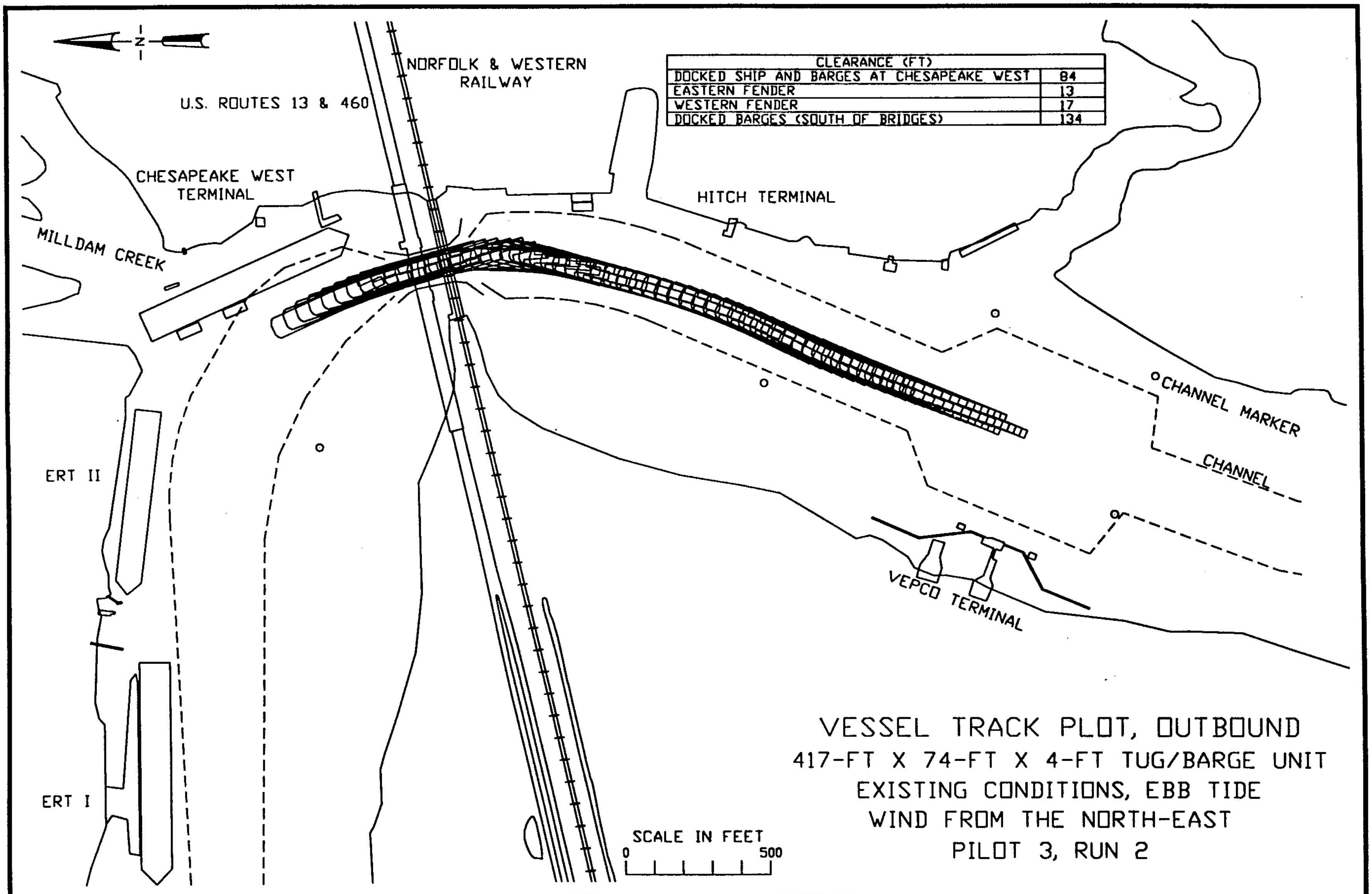
VESSEL TRACK PLOT, OUTBOUND
584-FT X 94-FT X 20-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 2



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	N/A
EASTERN FENDER	1
WESTERN FENDER	52
DOCKED BARGES (SOUTH OF BRIDGES)	122

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1

Plate 76



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	84
EASTERN FENDER	13
WESTERN FENDER	17
DOCKED BARGES (SOUTH OF BRIDGES)	134

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 2

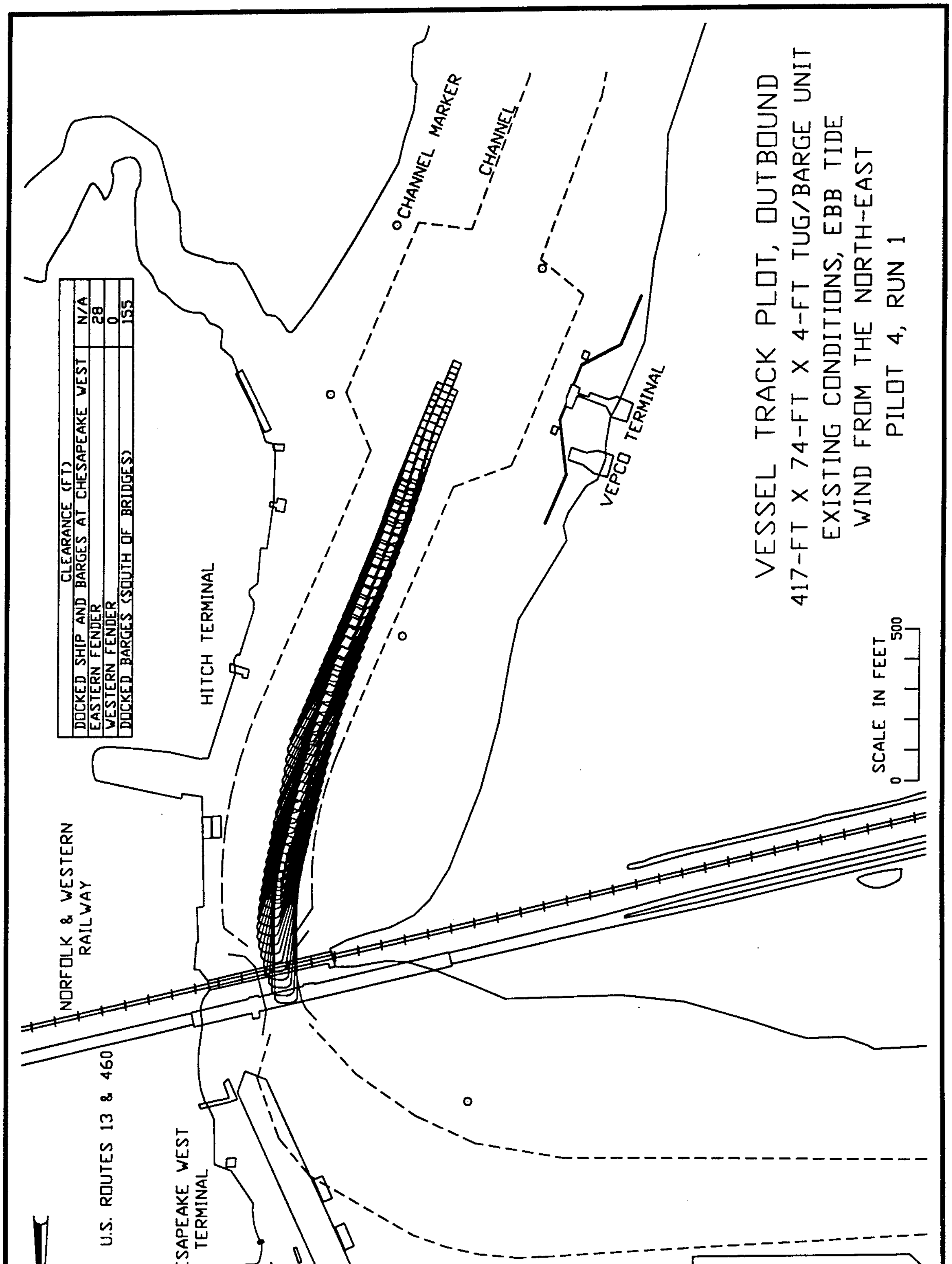
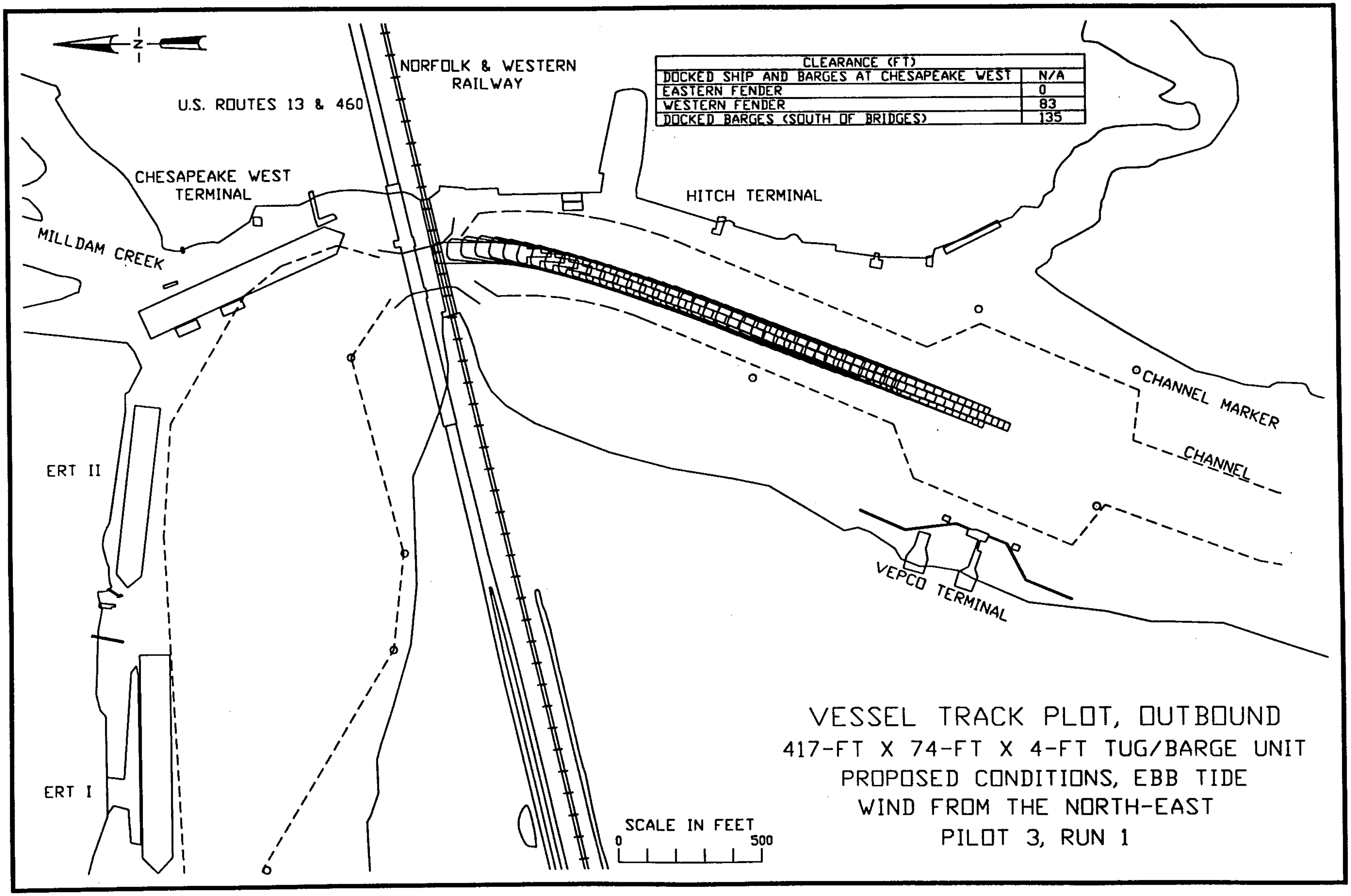
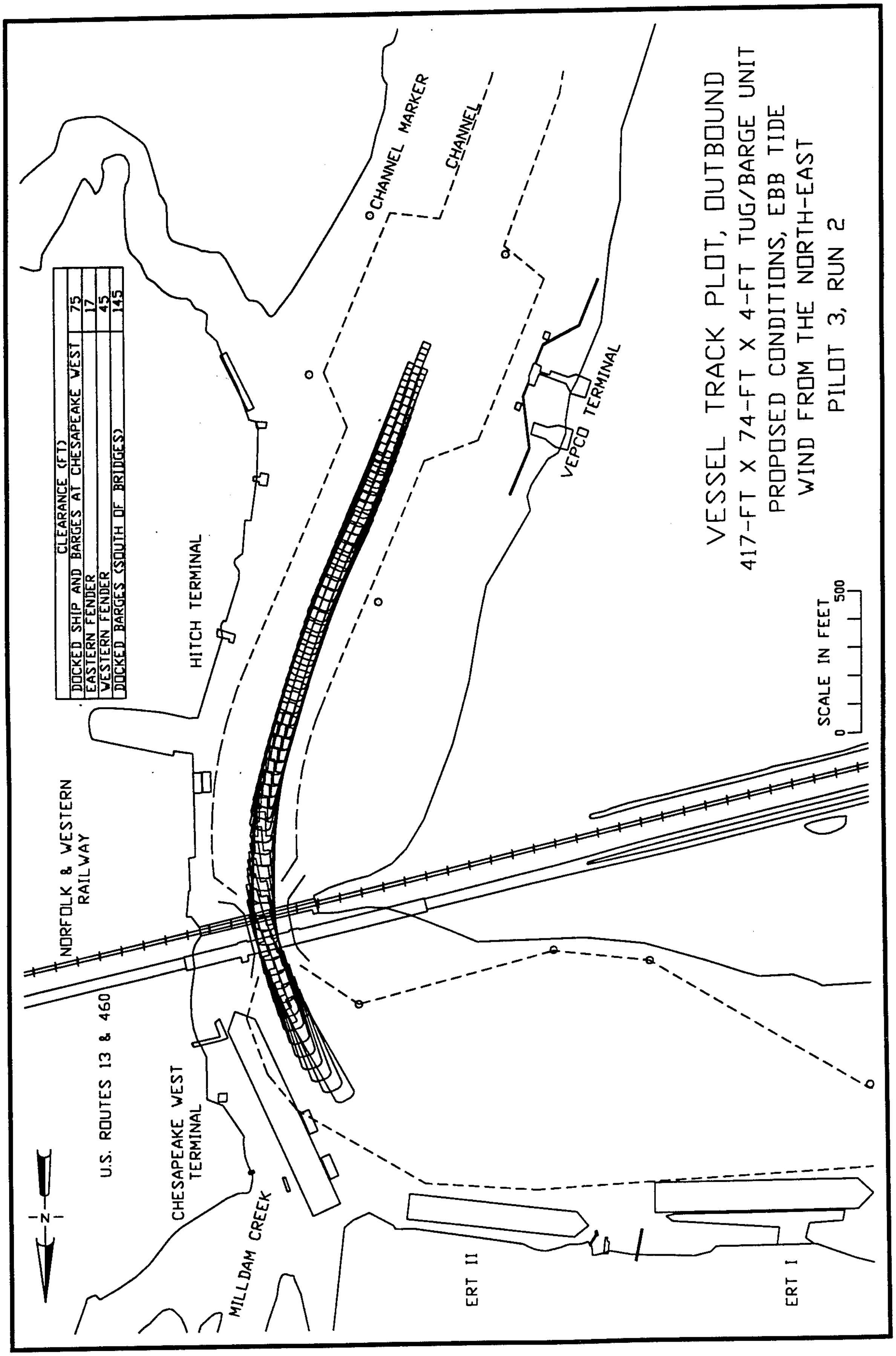

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST N/A
EASTERN FENDER 28
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 155
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 78



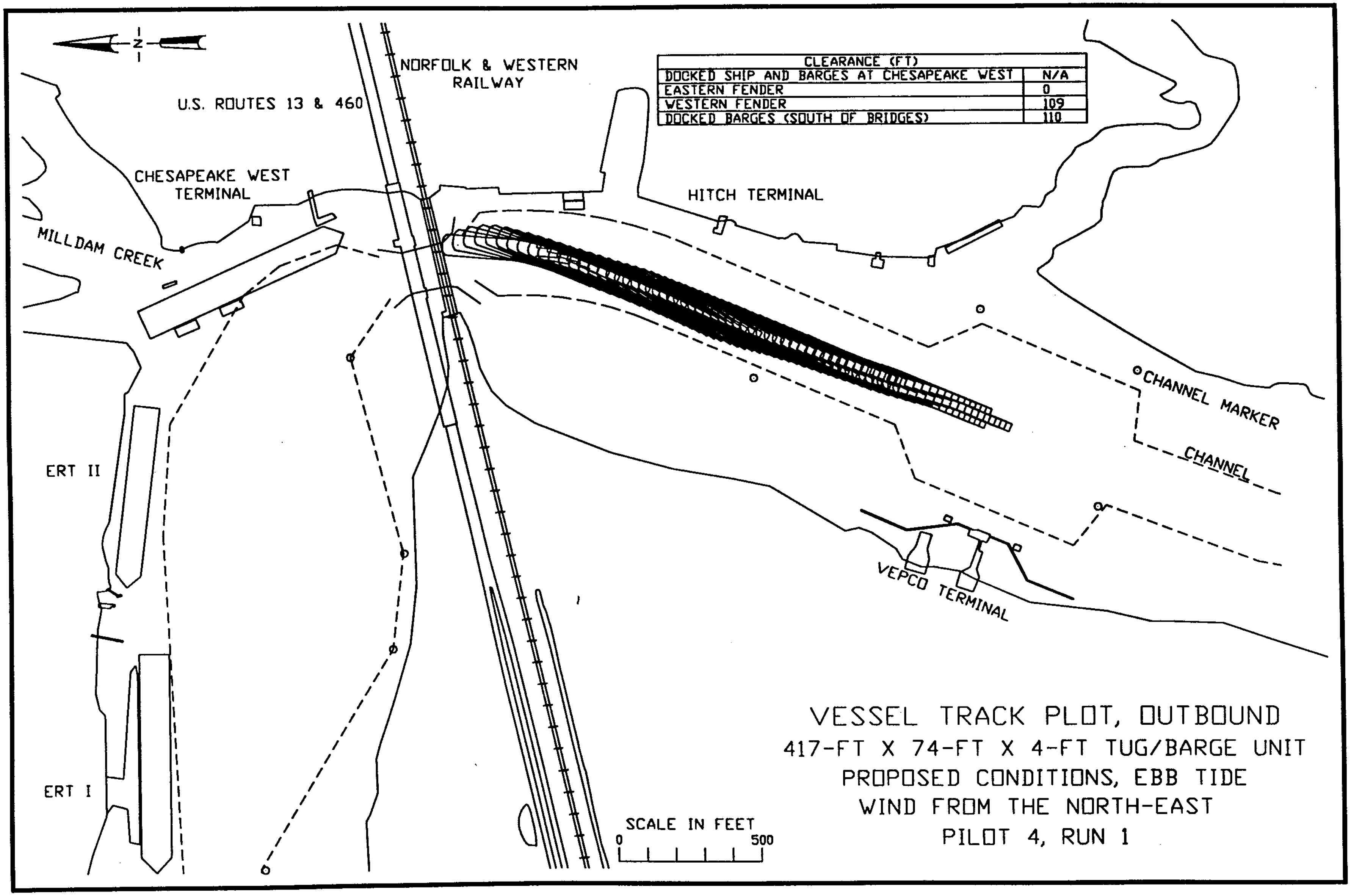
CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	N/A
EASTERN FENDER	0
WESTERN FENDER	83
DOCKED BARGES (SOUTH OF BRIDGES)	135

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1



VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 75
EASTERN FENDER 17
WESTERN FENDER 45
DOCKED BARGES (SOUTH OF BRIDGES) 145
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 80



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	N/A
EASTERN FENDER	0
WESTERN FENDER	109
DOCKED BARGES (SOUTH OF BRIDGES)	110

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1

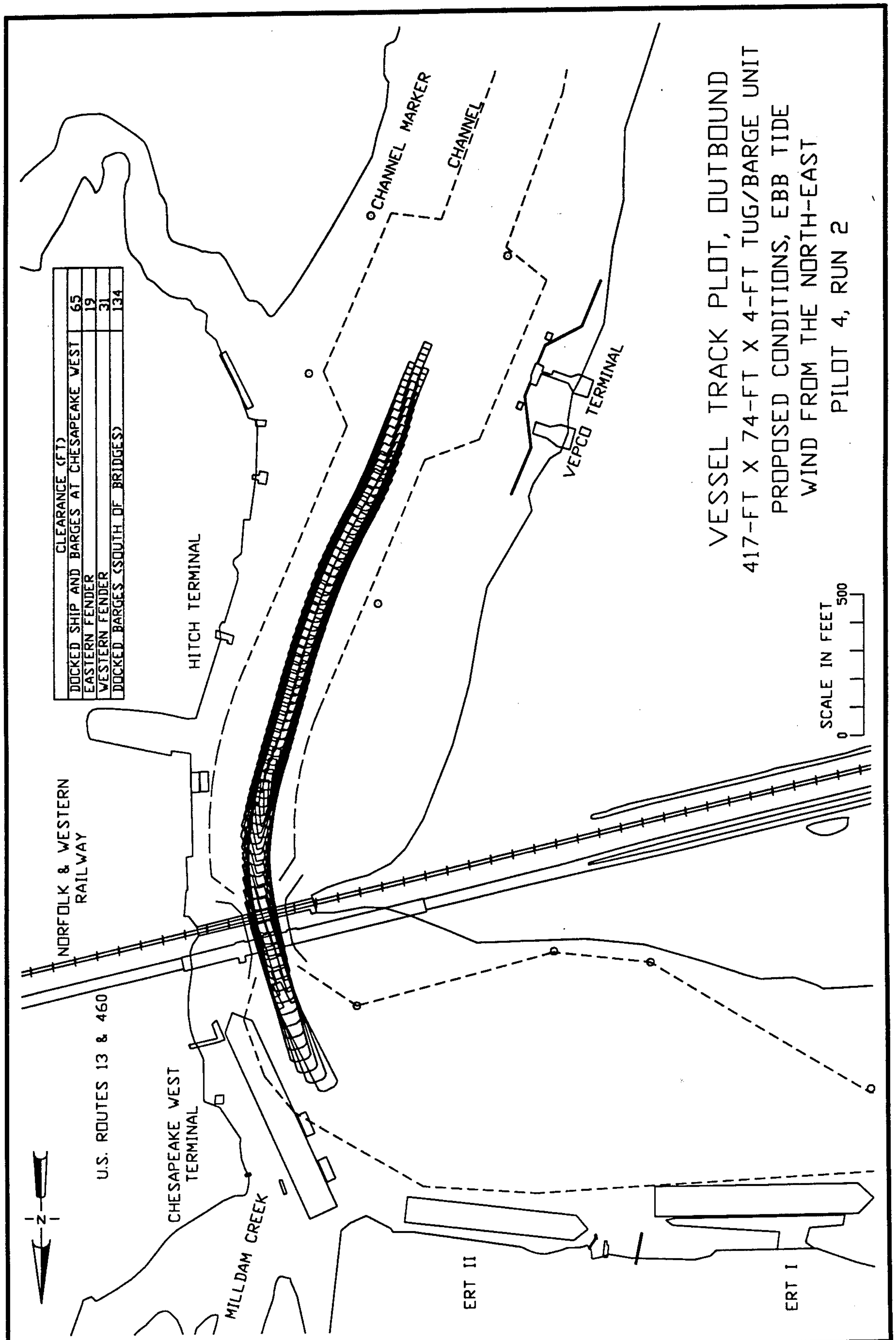
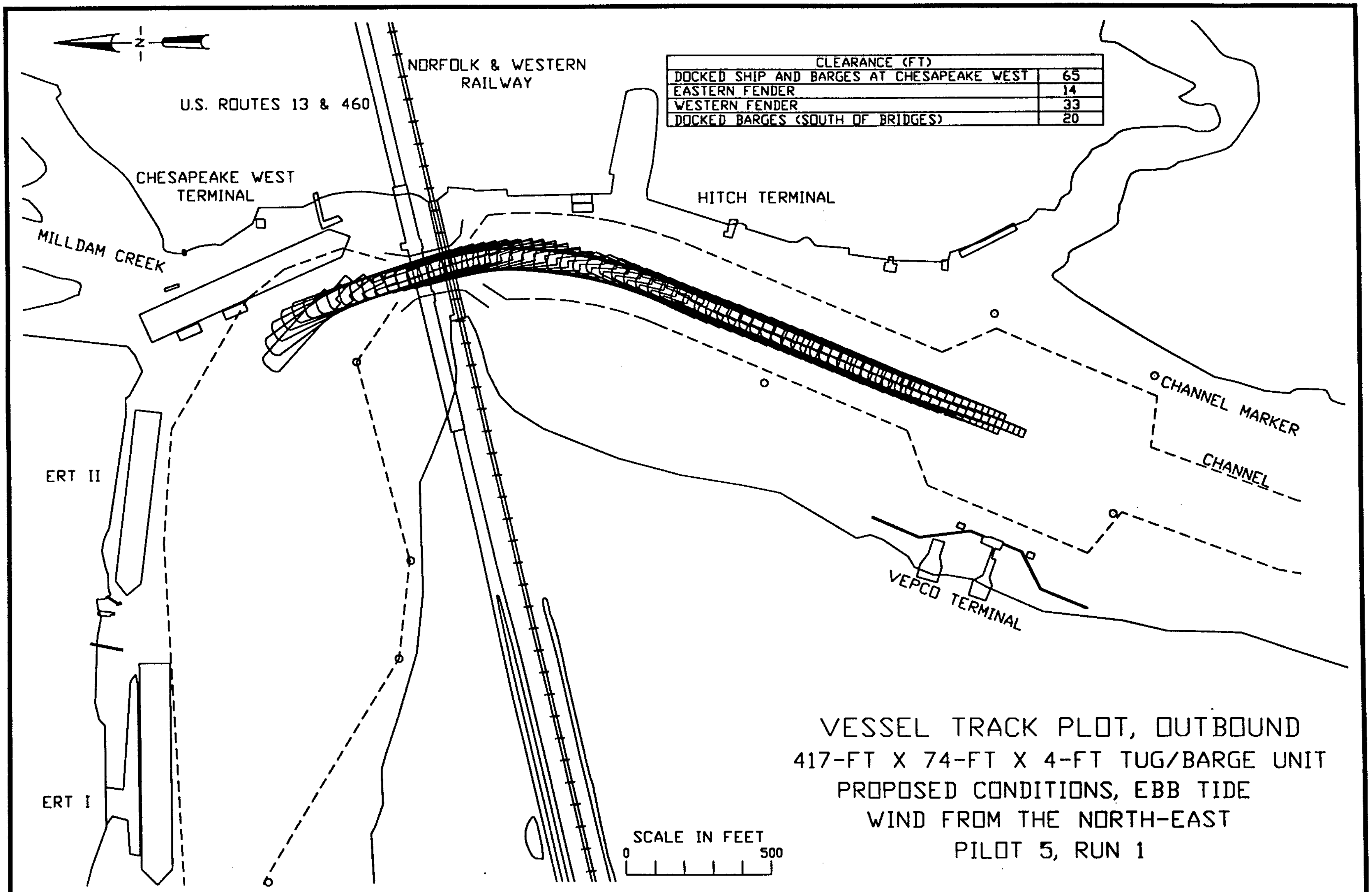

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 2
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 65
EASTERN FENDER 19
WESTERN FENDER 31
DOCKED BARGES (SOUTH OF BRIDGES) 134
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 82



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	65
EASTERN FENDER	14
WESTERN FENDER	33
DOCKED BARGES (SOUTH OF BRIDGES)	20

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1

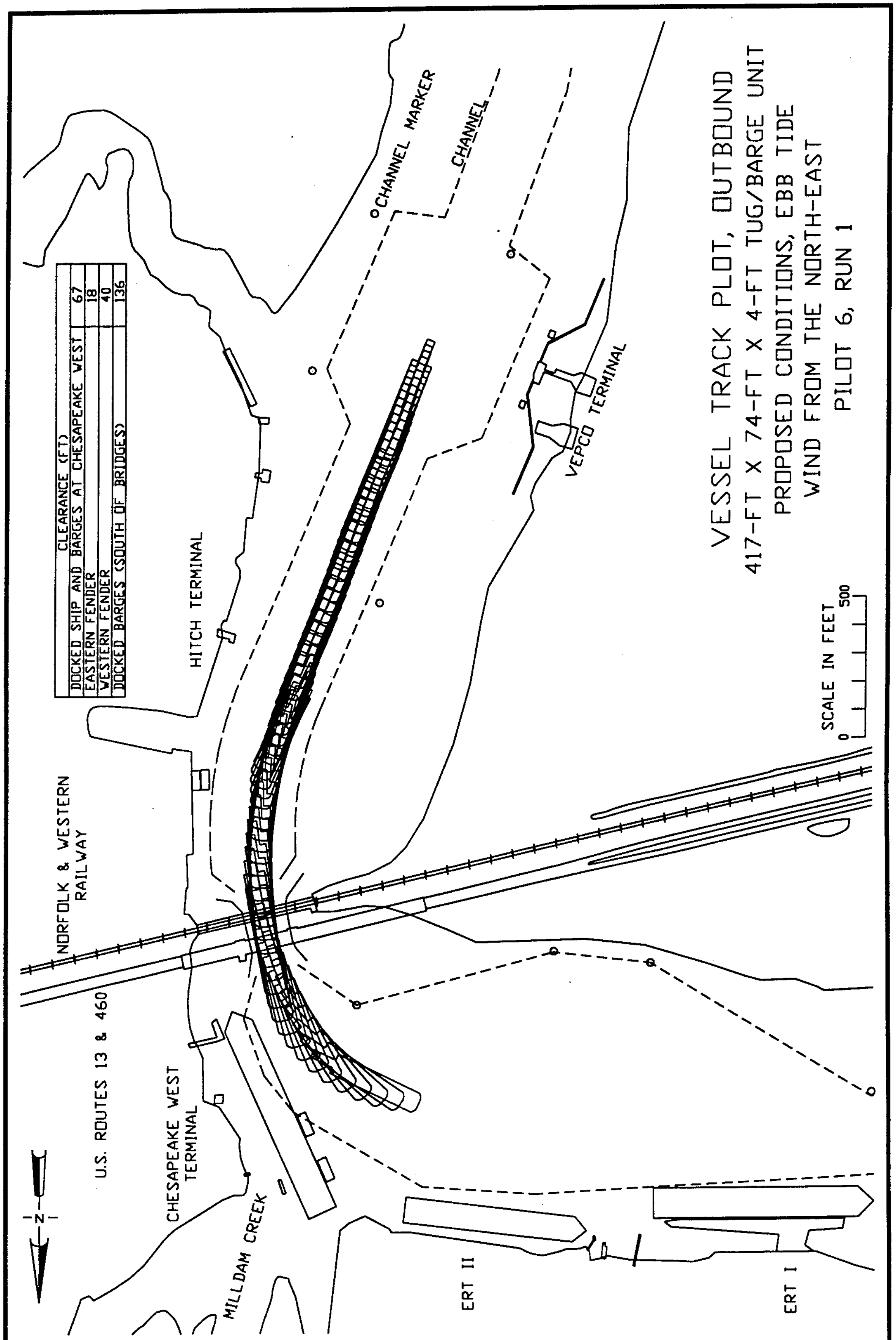
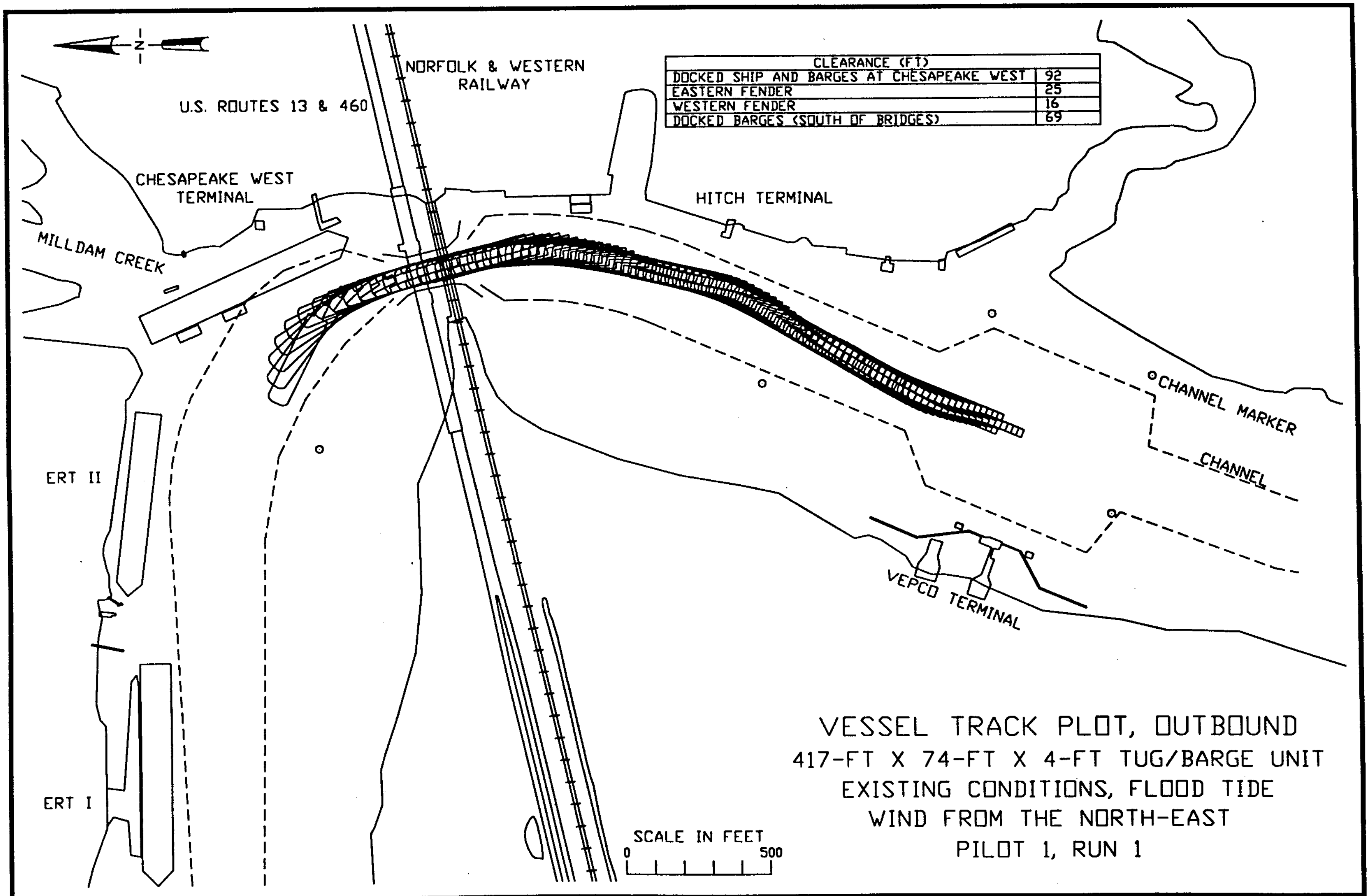
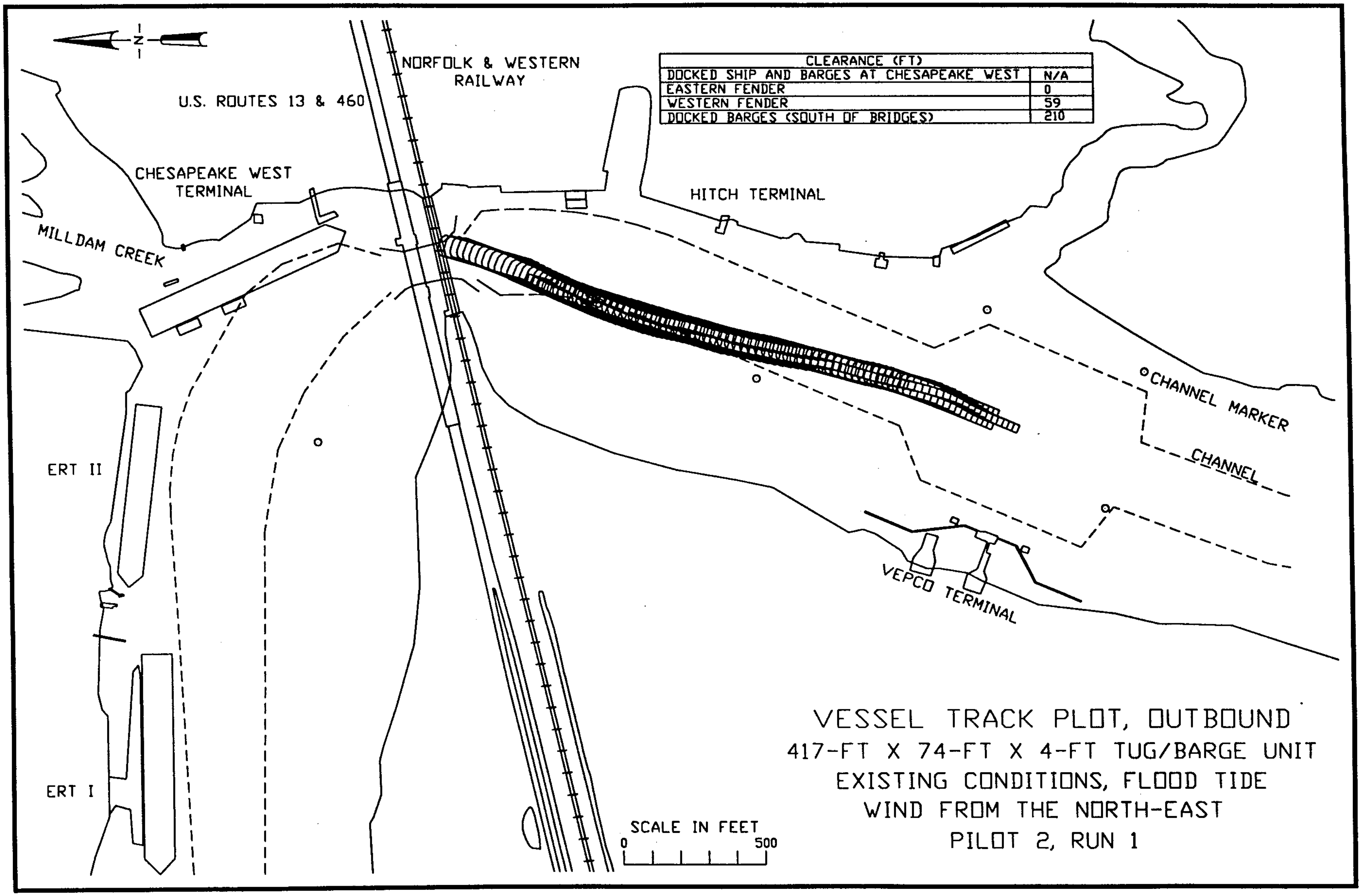

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 67
EASTERN FENDER 18
WESTERN FENDER 40
DOCKED BARGES (SOUTH OF BRIDGES) 136
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 84



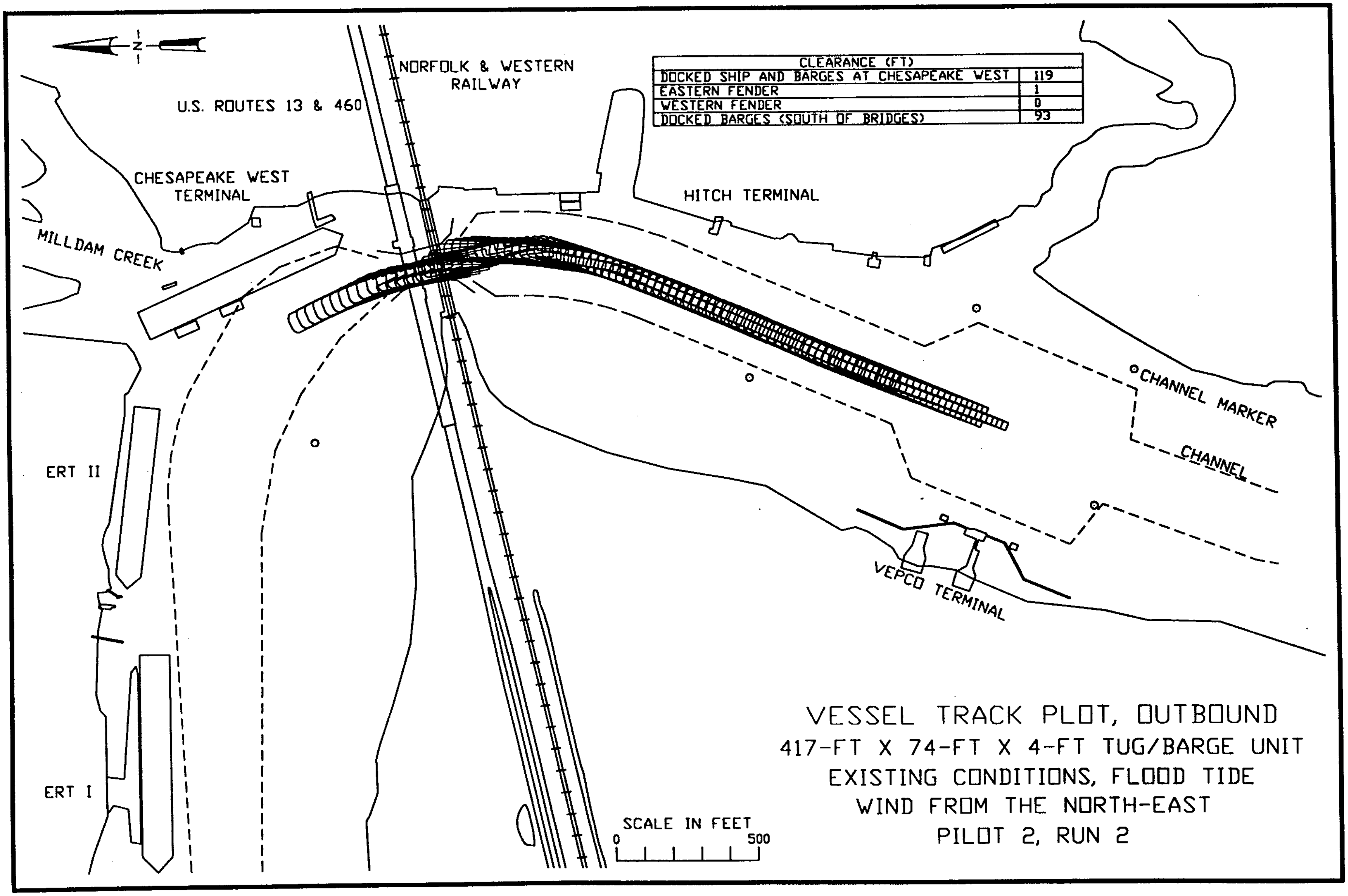
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	N/A
EASTERN FENDER	0
WESTERN FENDER	59
DOCKED BARGES (SOUTH OF BRIDGES)	210

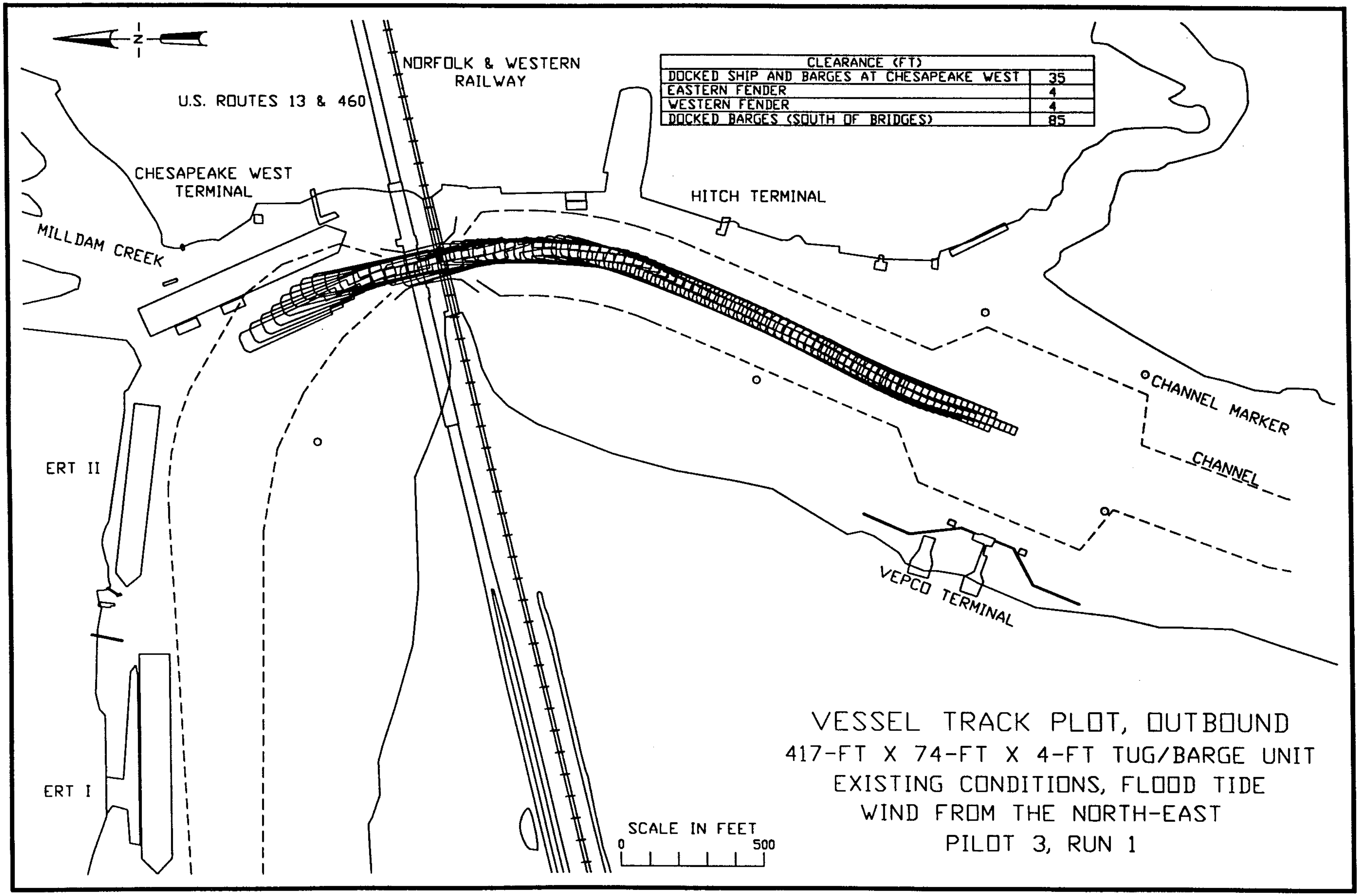
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1

Plate 86



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	119
EASTERN FENDER	1
WESTERN FENDER	0
DOCKED BARGES (SOUTH OF BRIDGES)	93

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 2



VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1

Plate 88

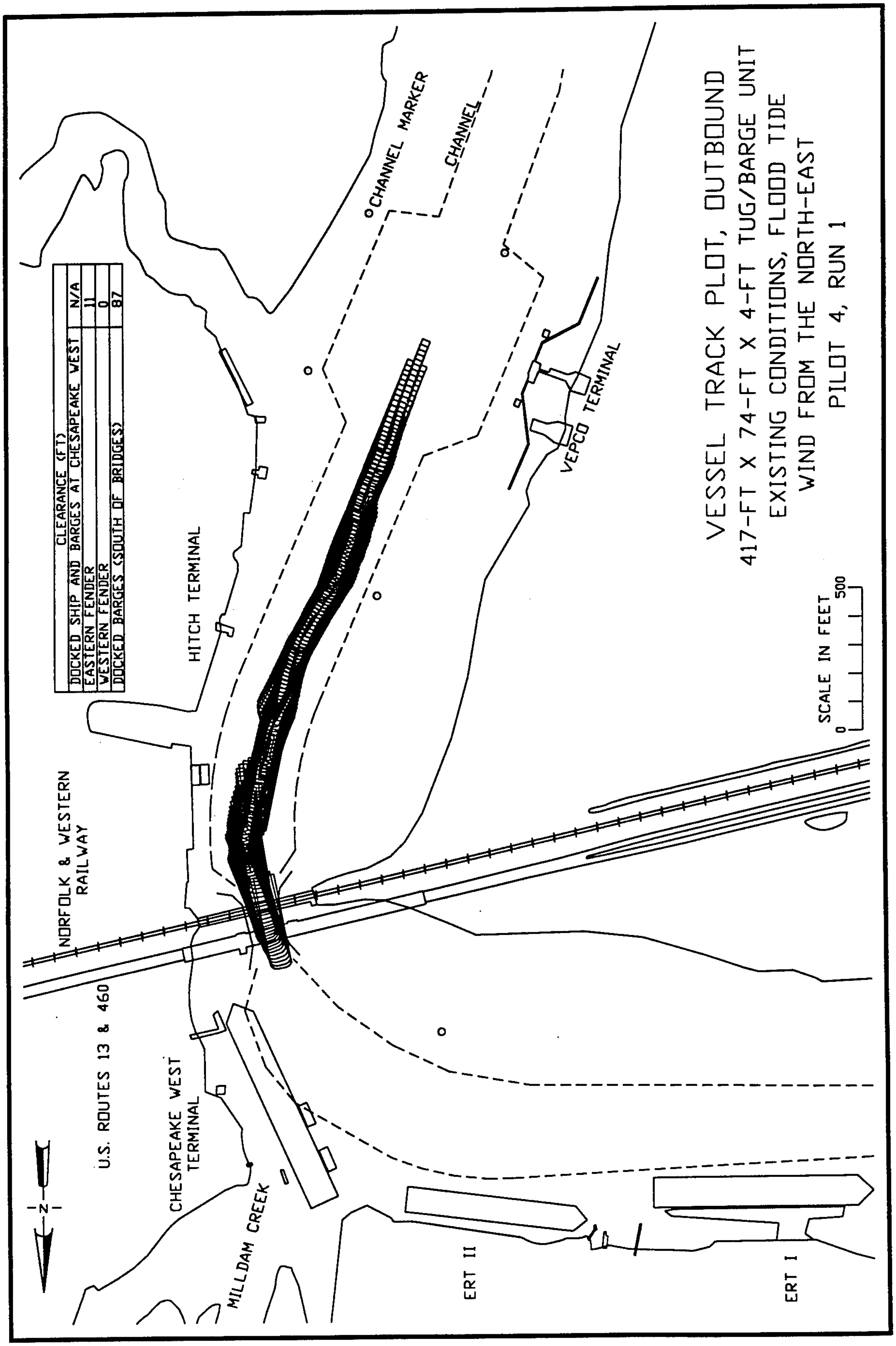

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST N/A
EASTERN FENDER 11
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 87
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 89

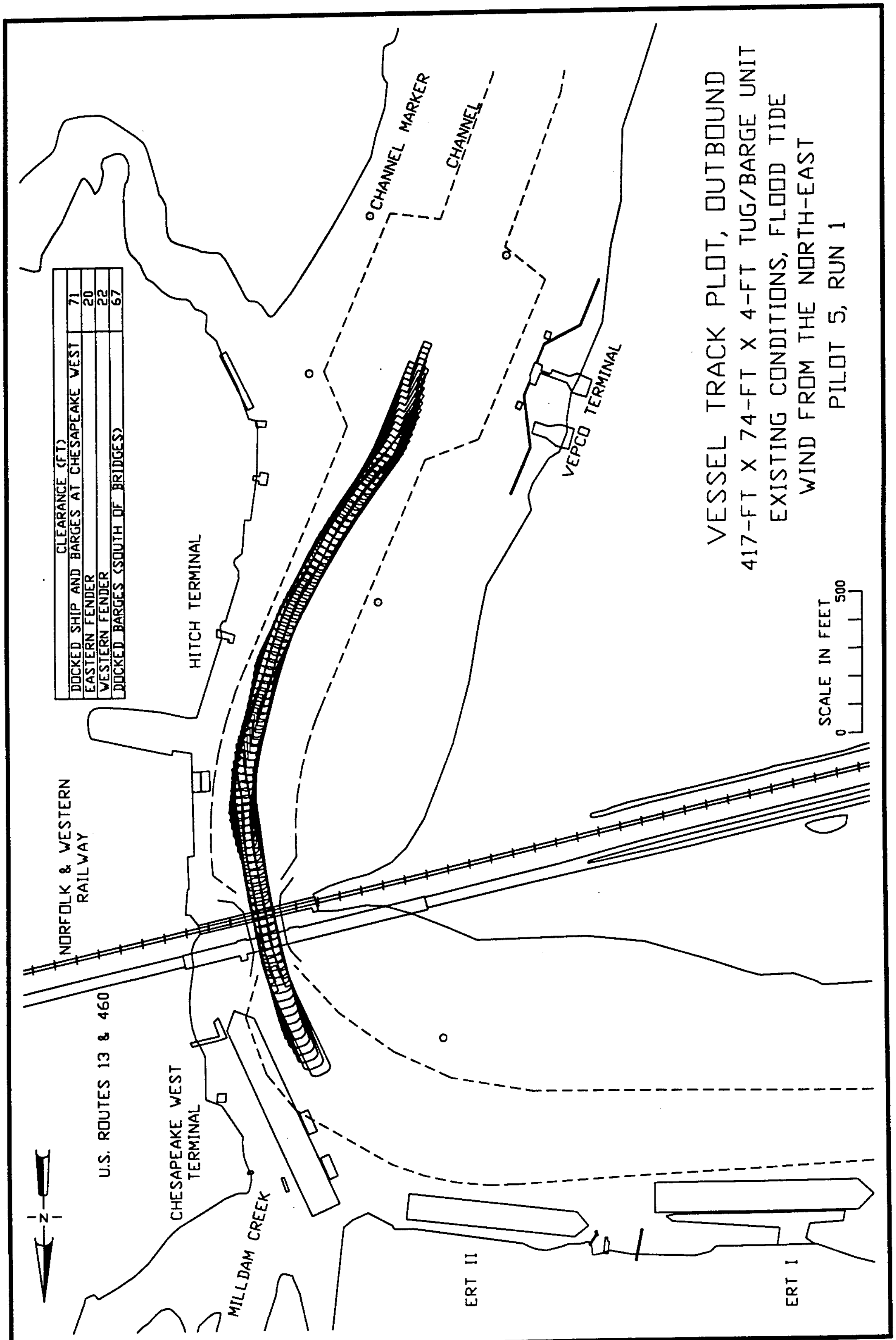
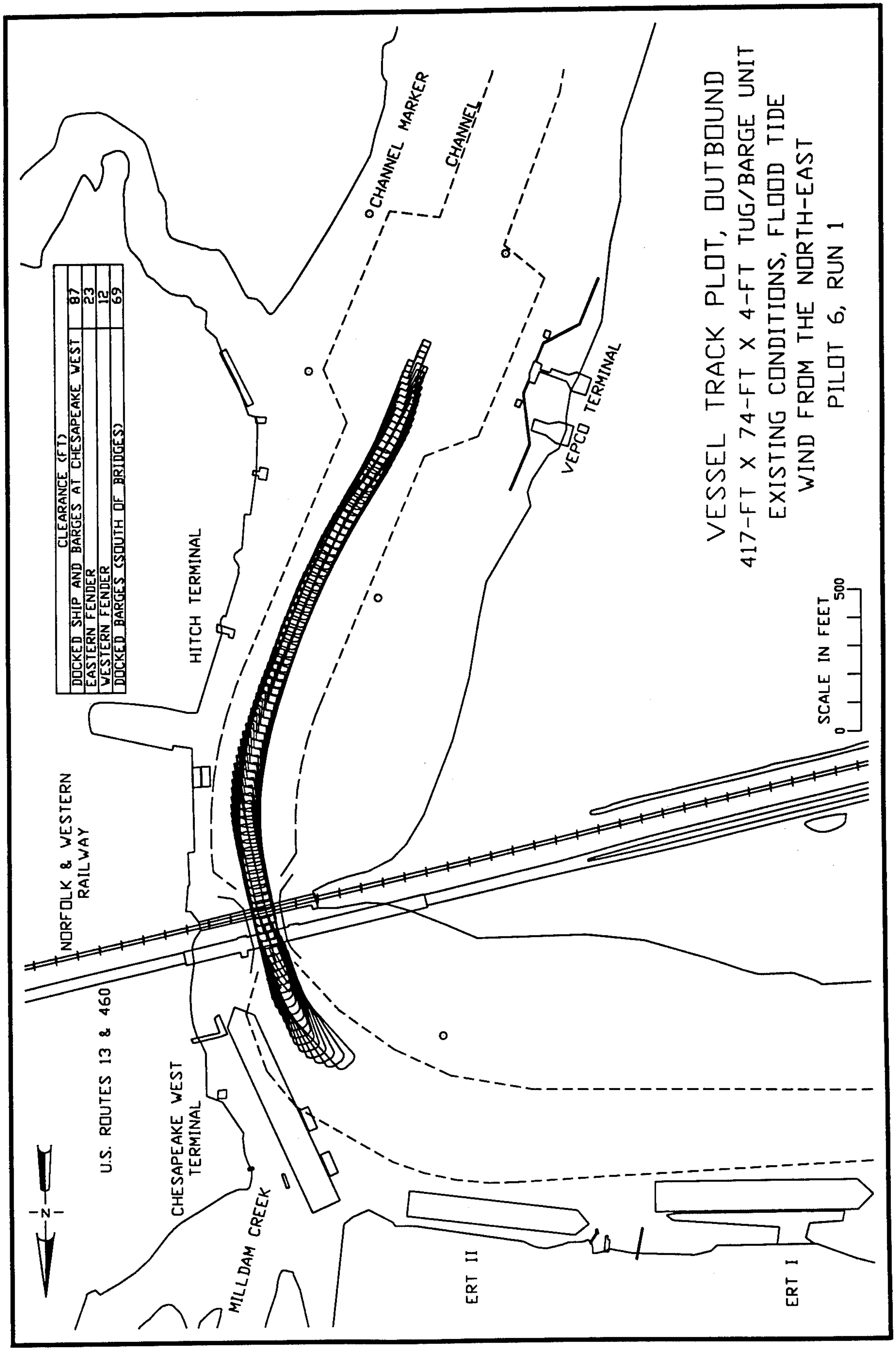

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 71
EASTERN FENDER 20
WESTERN FENDER 22
DOCKED BARGES (SOUTH OF BRIDGES) 67
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
HITCH TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 90



VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 87
EASTERN FENDER 23
WESTERN FENDER 12
DOCKED BARGES (SOUTH OF BRIDGES) 69
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 91

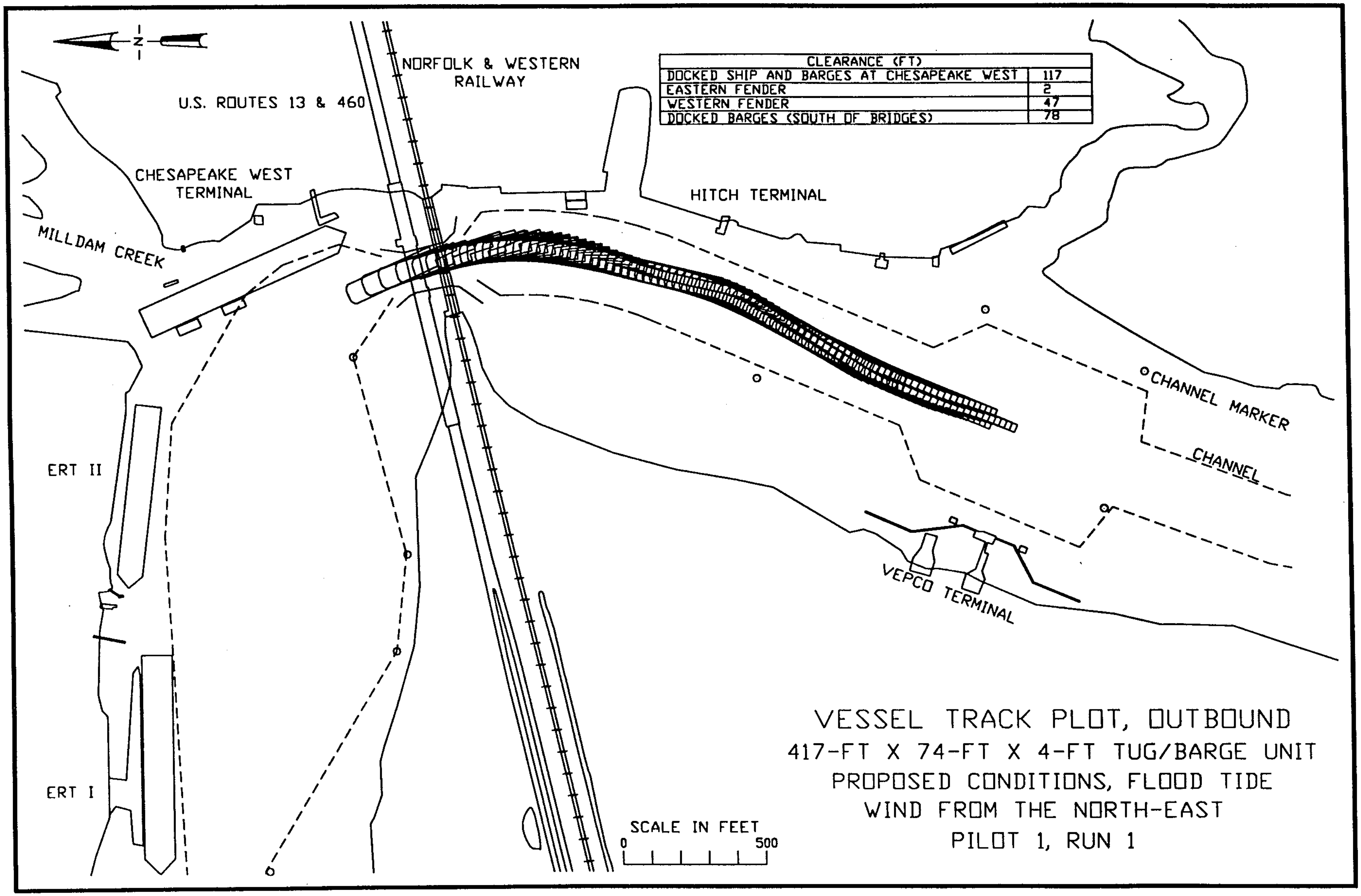
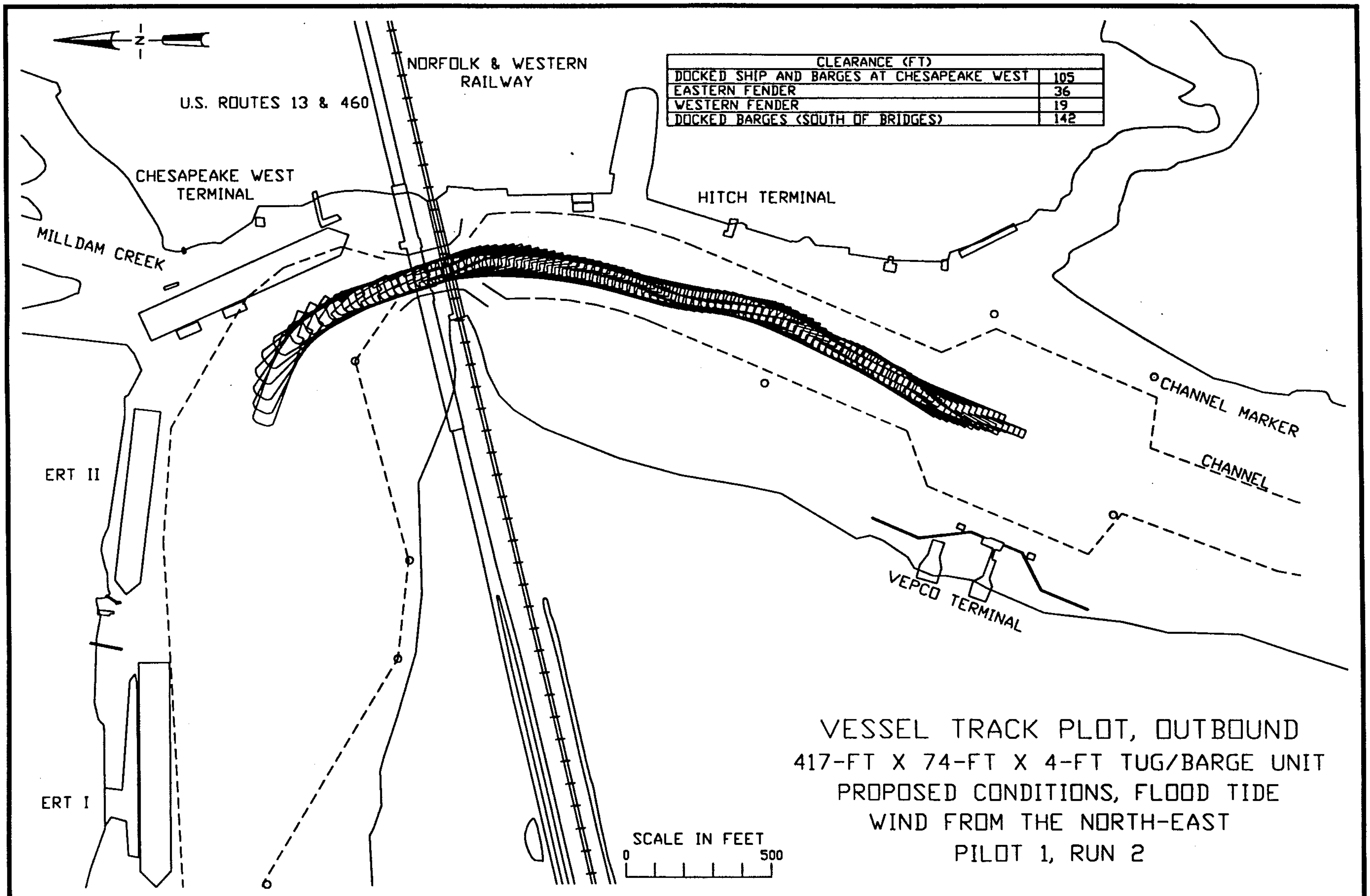

CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 117
EASTERN FENDER 2
WESTERN FENDER 47
DOCKED BARGES (SOUTH OF BRIDGES) 78
N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
HITCH TERMINAL
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
ERT II
ERT I
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1

Plate 92



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	105
EASTERN FENDER	36
WESTERN FENDER	19
DOCKED BARGES (SOUTH OF BRIDGES)	142

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 2

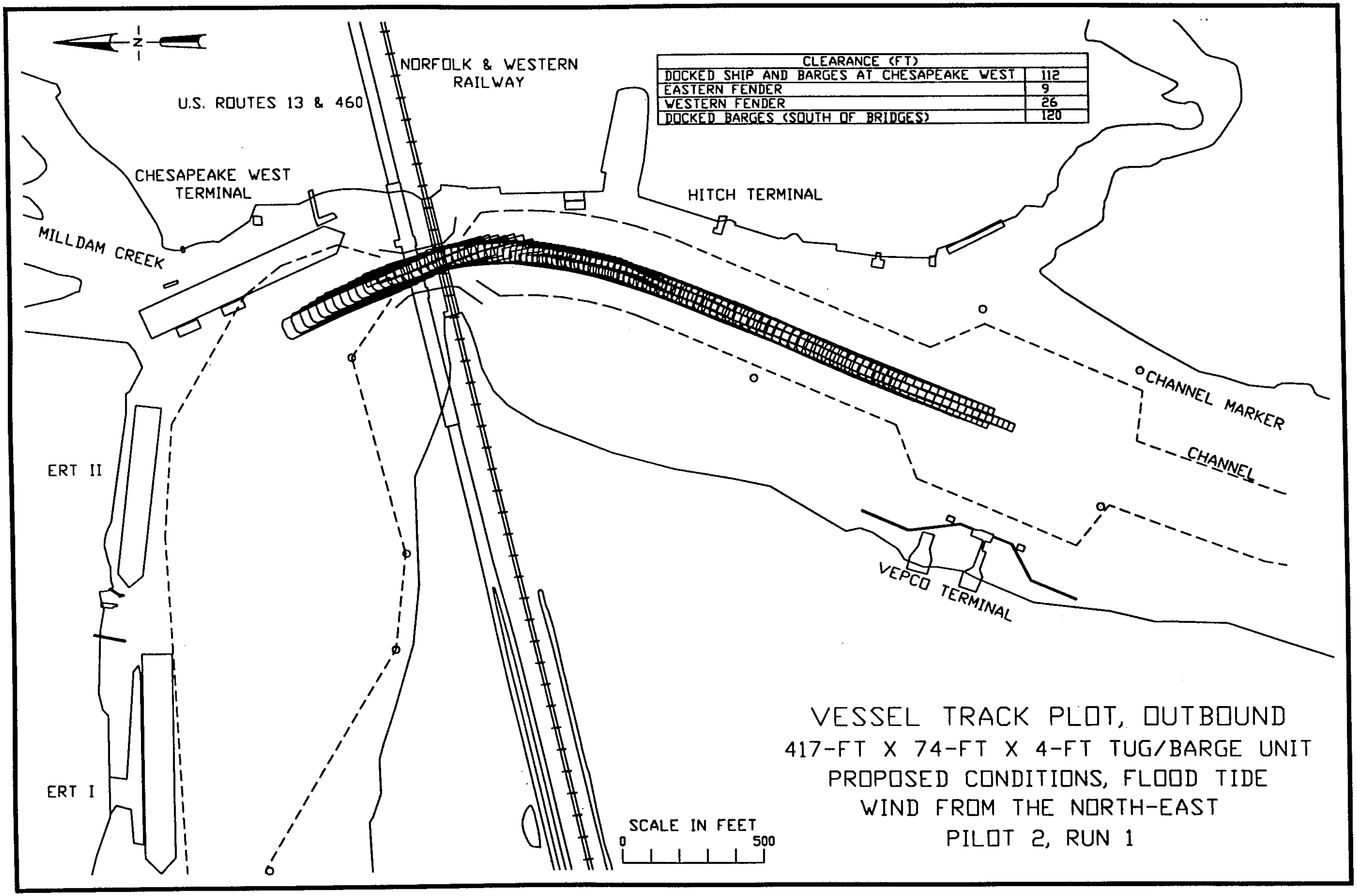
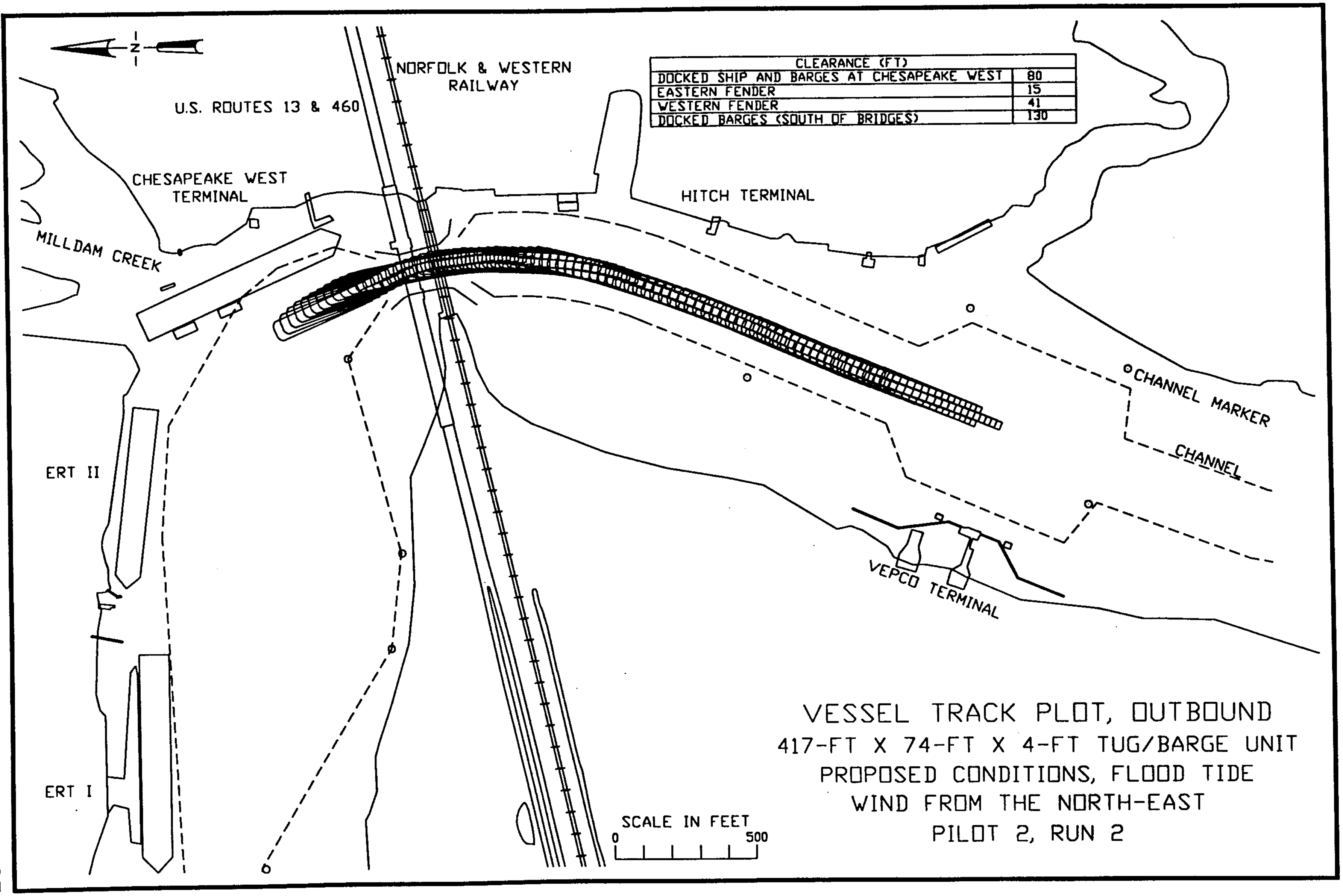

N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 112
EASTERN FENDER 9
WESTERN FENDER 26
DOCKED BARGES (SOUTH OF BRIDGES) 120
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1

Plate 94



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	80
EASTERN FENDER	15
WESTERN FENDER	41
DOCKED BARGES (SOUTH OF BRIDGES)	130

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 2

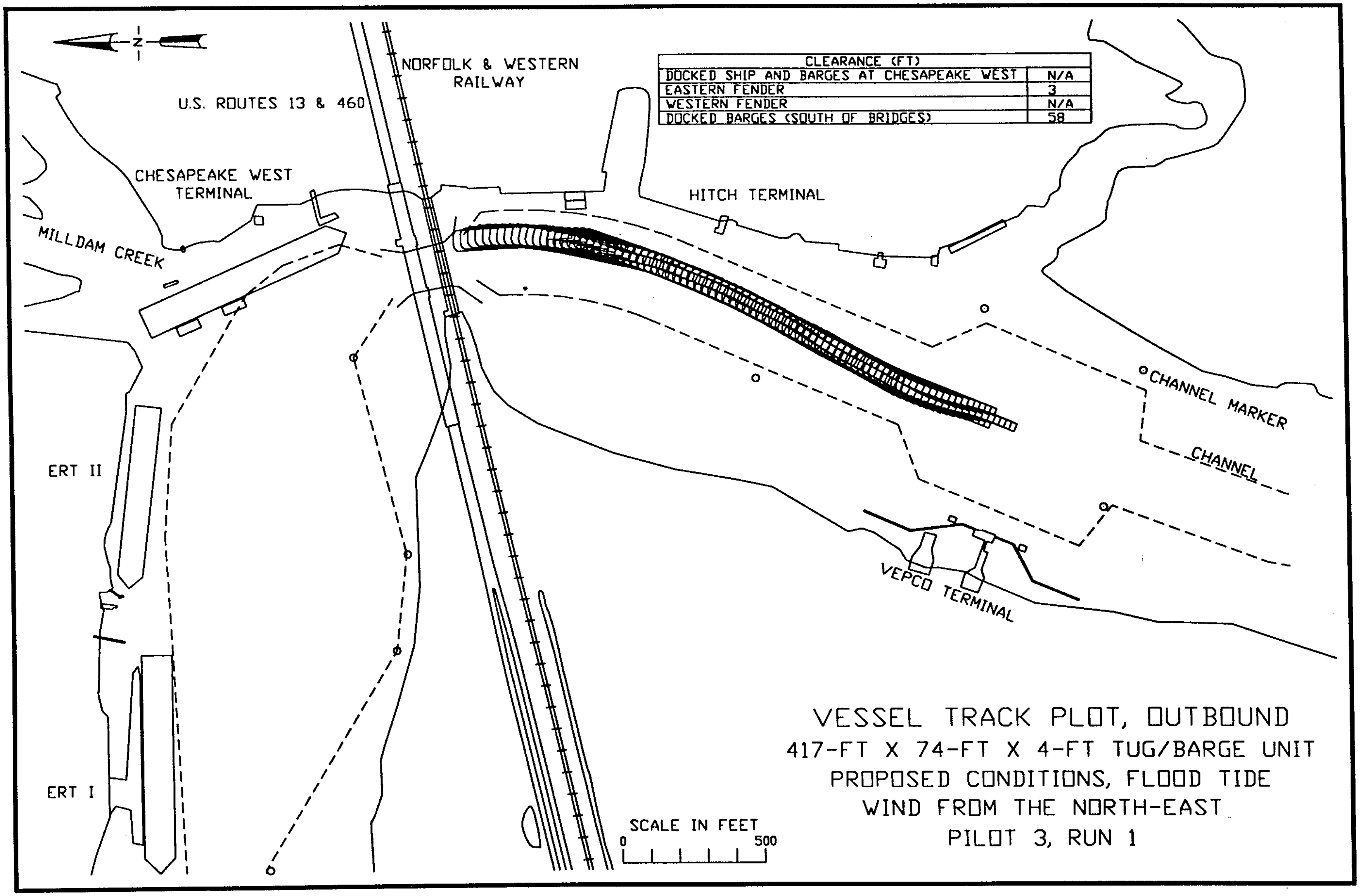
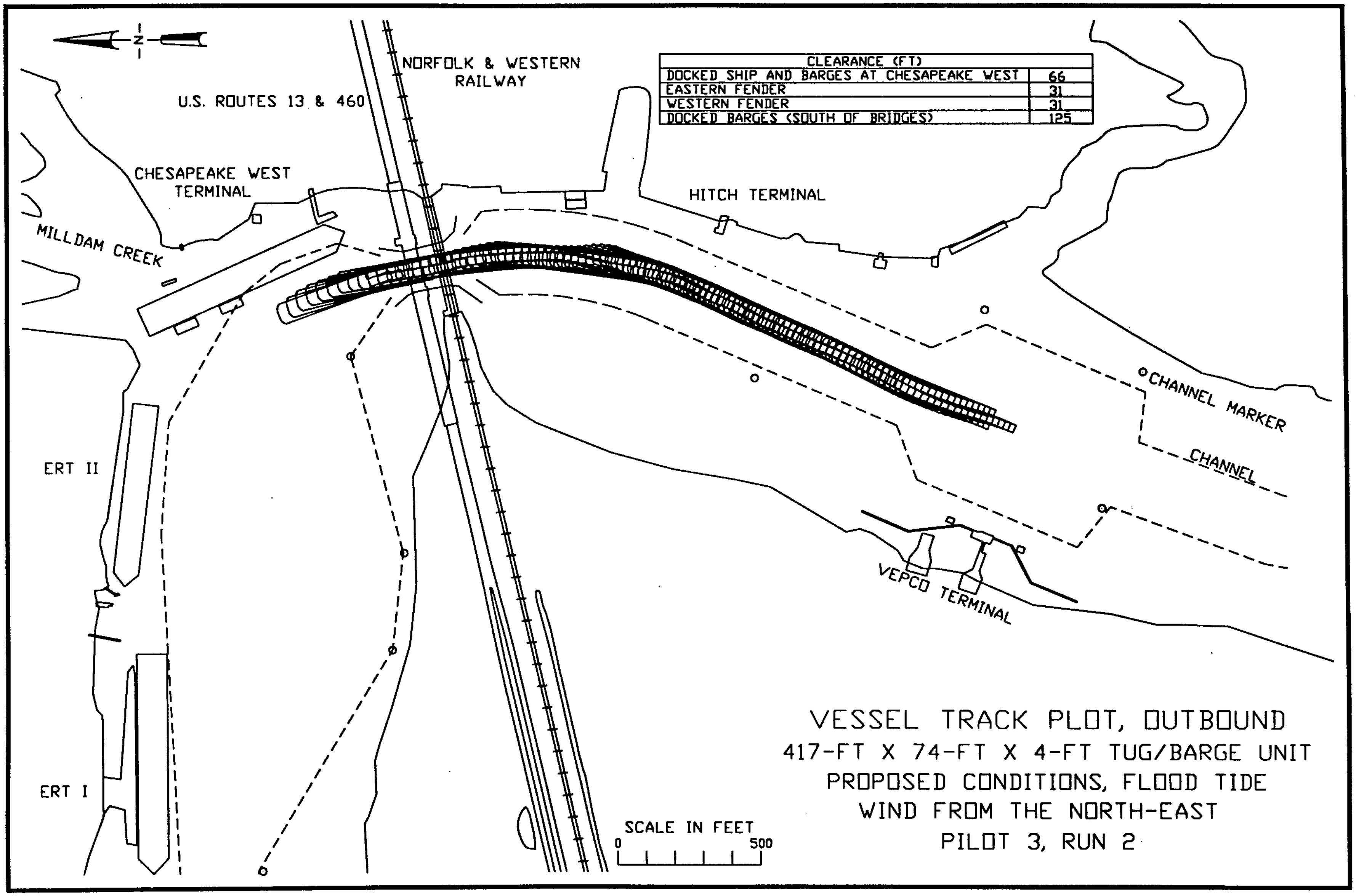
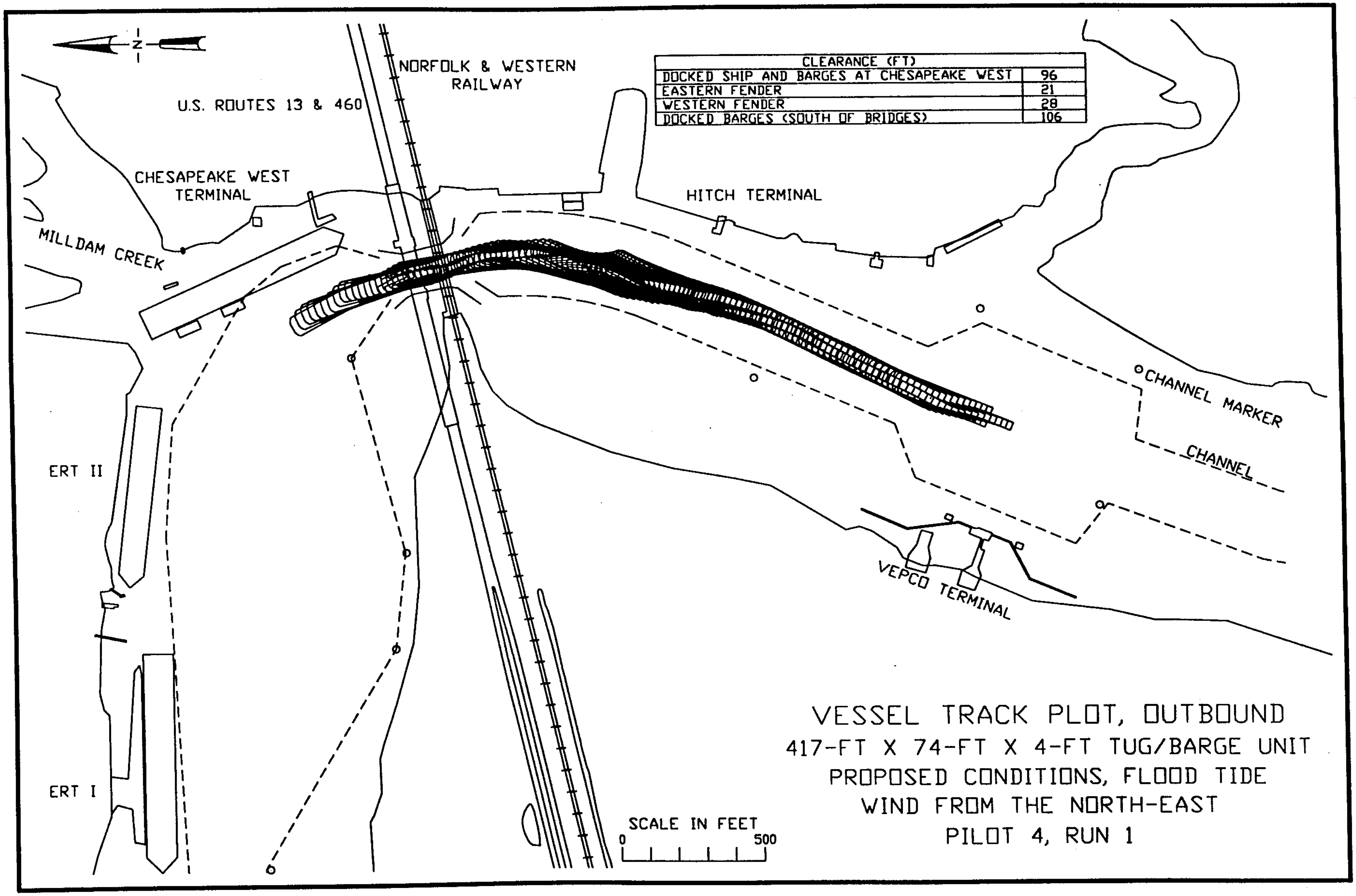

N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST N/A
EASTERN FENDER 3
WESTERN FENDER N/A
DOCKED BARGES (SOUTH OF BRIDGES) 58
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1

Plate 96

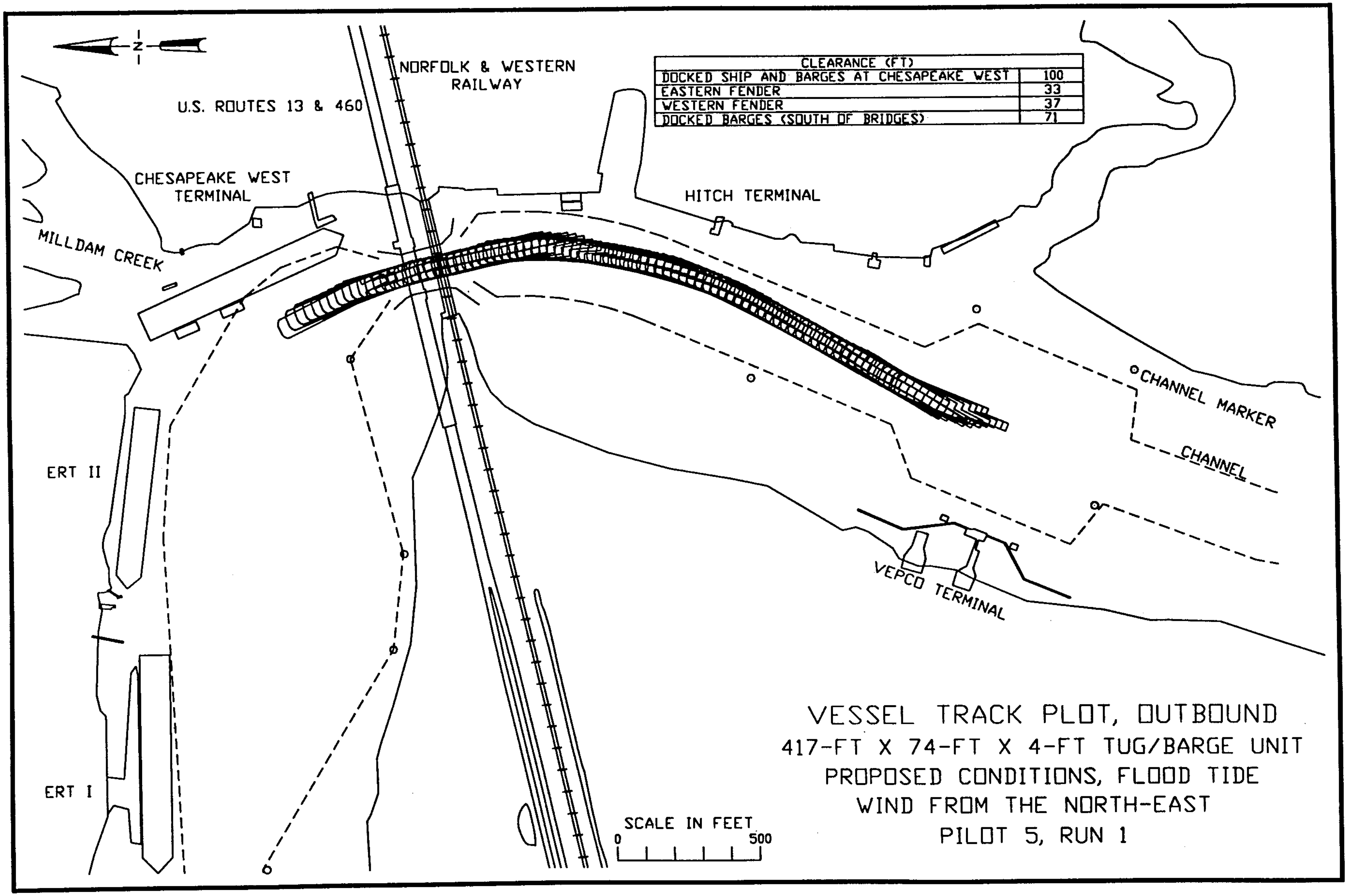

N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 66
EASTERN FENDER 31
WESTERN FENDER 31
DOCKED BARGES (SOUTH OF BRIDGES) 125
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 2



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	96
EASTERN FENDER	21
WESTERN FENDER	28
DOCKED BARGES (SOUTH OF BRIDGES)	106

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1

Plate 98



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	100
EASTERN FENDER	33
WESTERN FENDER	37
DOCKED BARGES (SOUTH OF BRIDGES)	71

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1

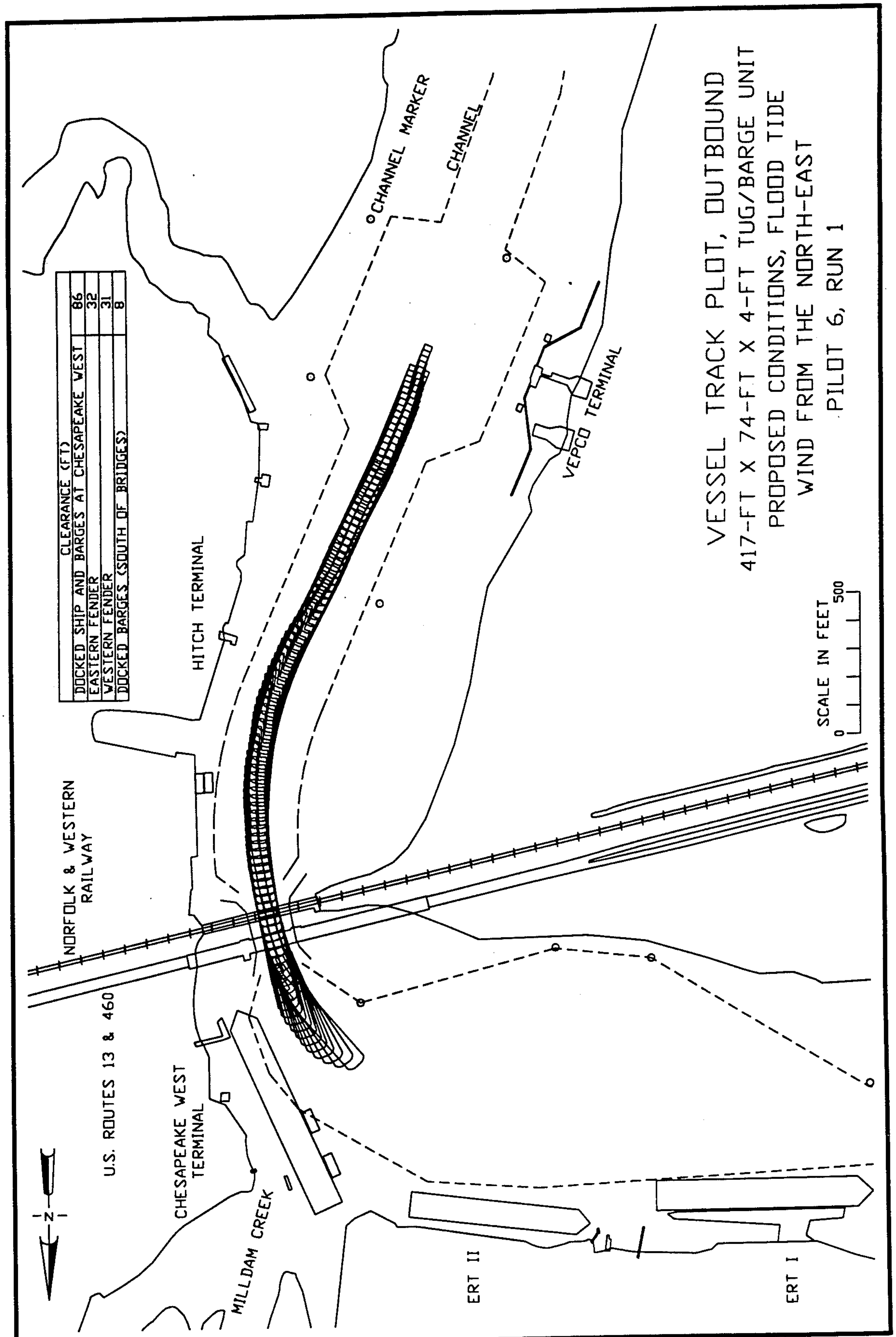
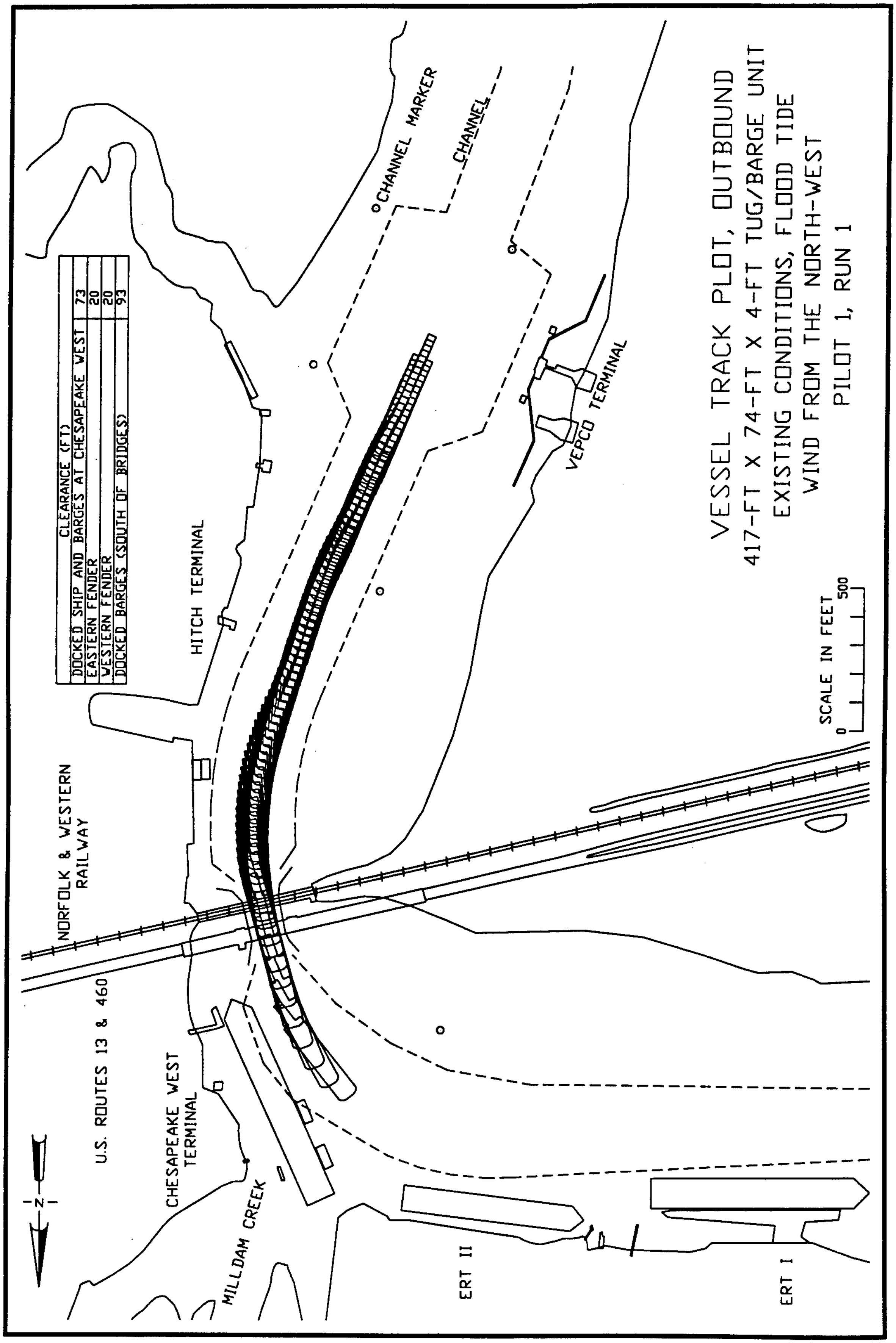

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 86
EASTERN FENDER 32
WESTERN FENDER 31
DOCKED BARGES (SOUTH OF BRIDGES) 8
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 100



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	73
EASTERN FENDER	20
WESTERN FENDER	20
DOCKED BARGES (SOUTH OF BRIDGES)	93

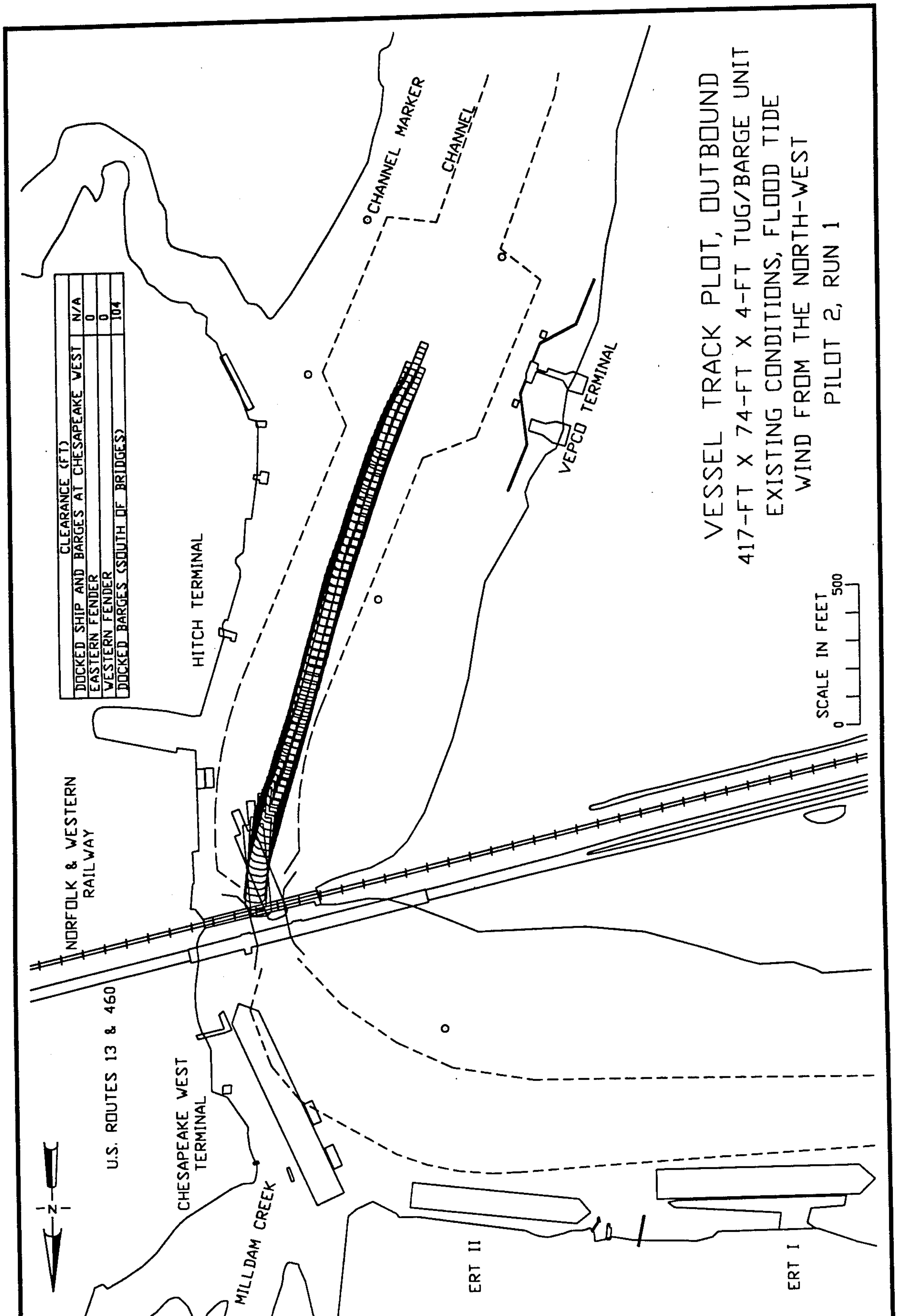
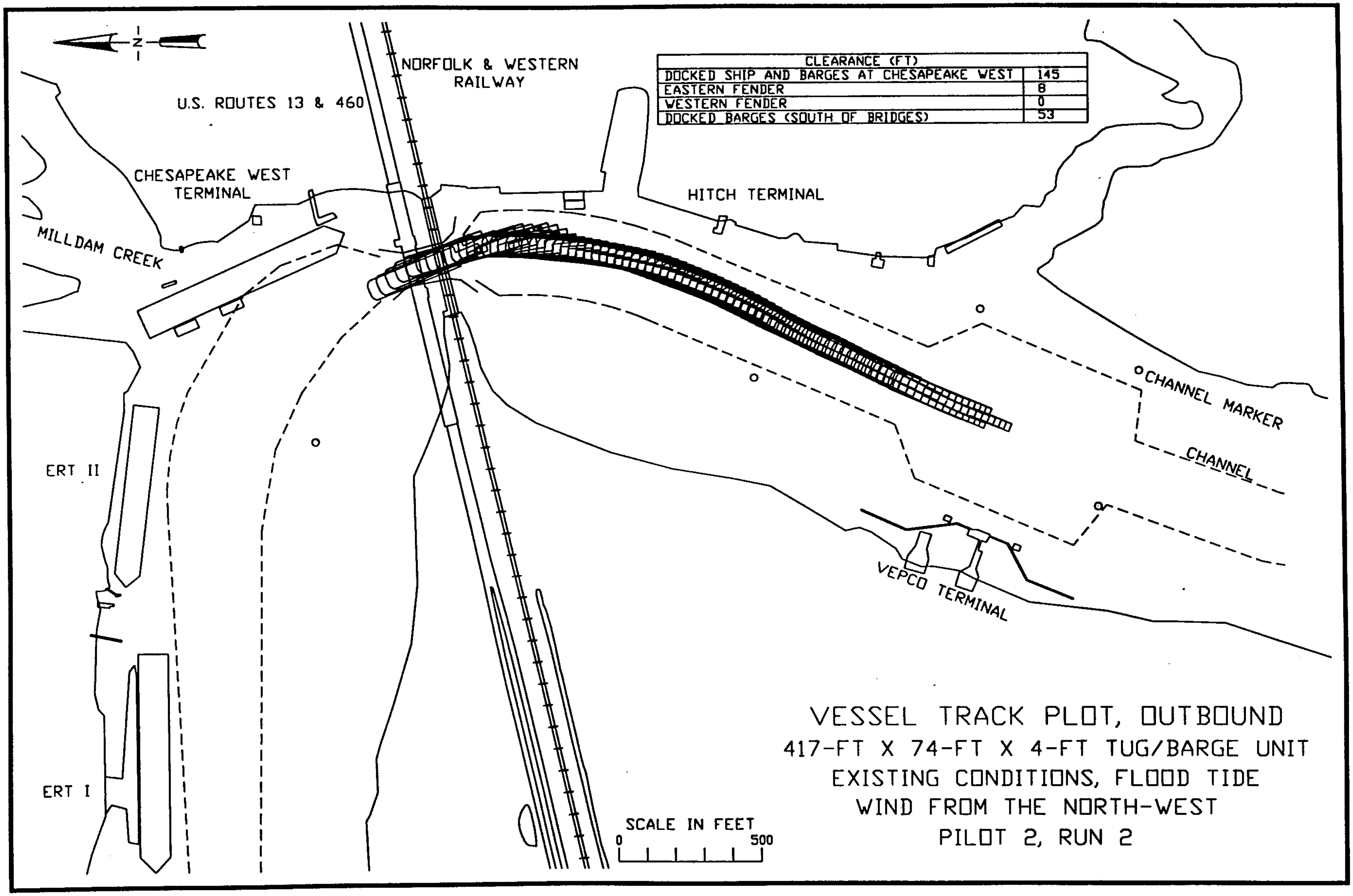

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 2, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST N/A
EASTERN FENDER 0
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 104
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 102



VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 2, RUN 2

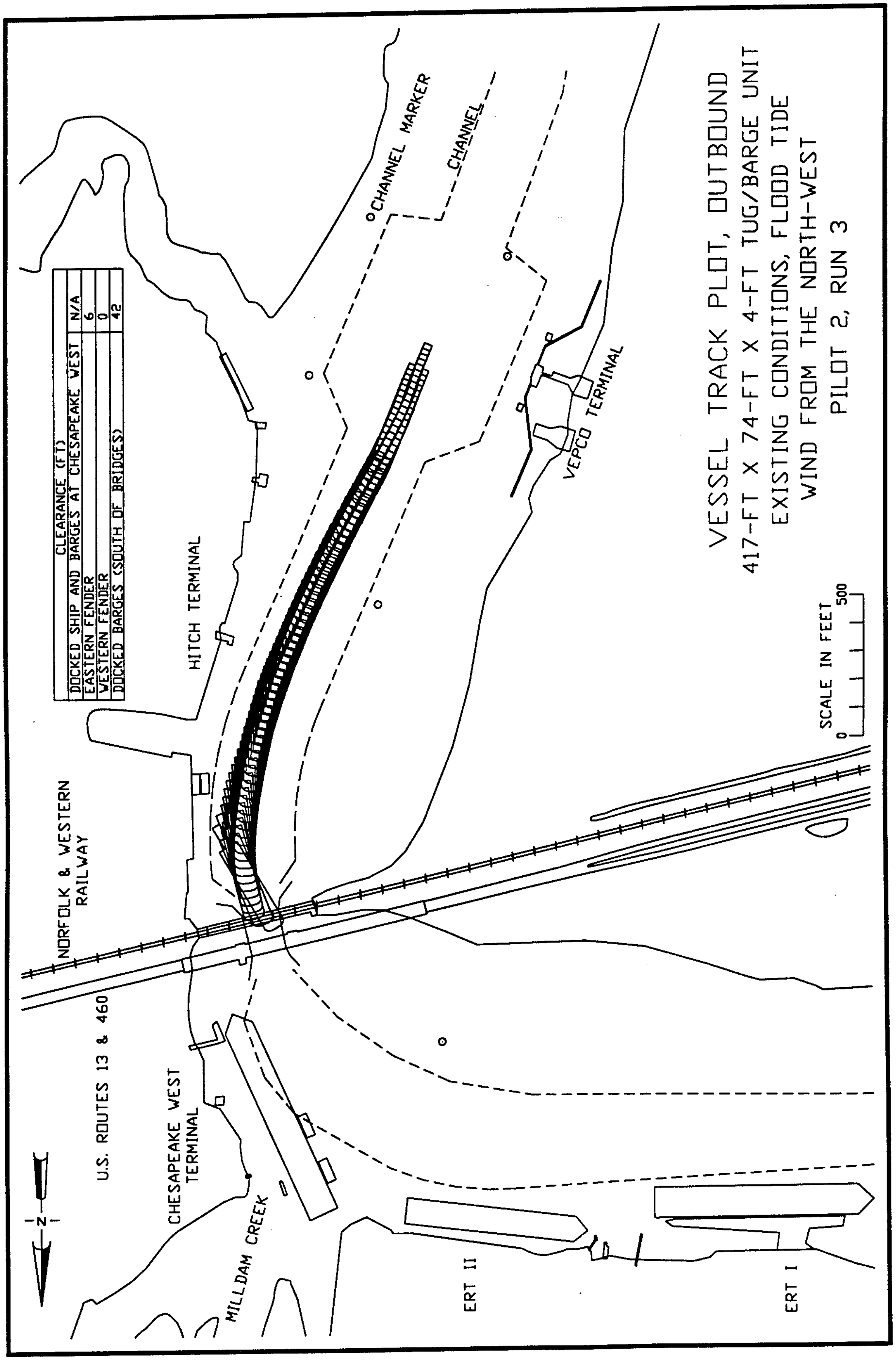
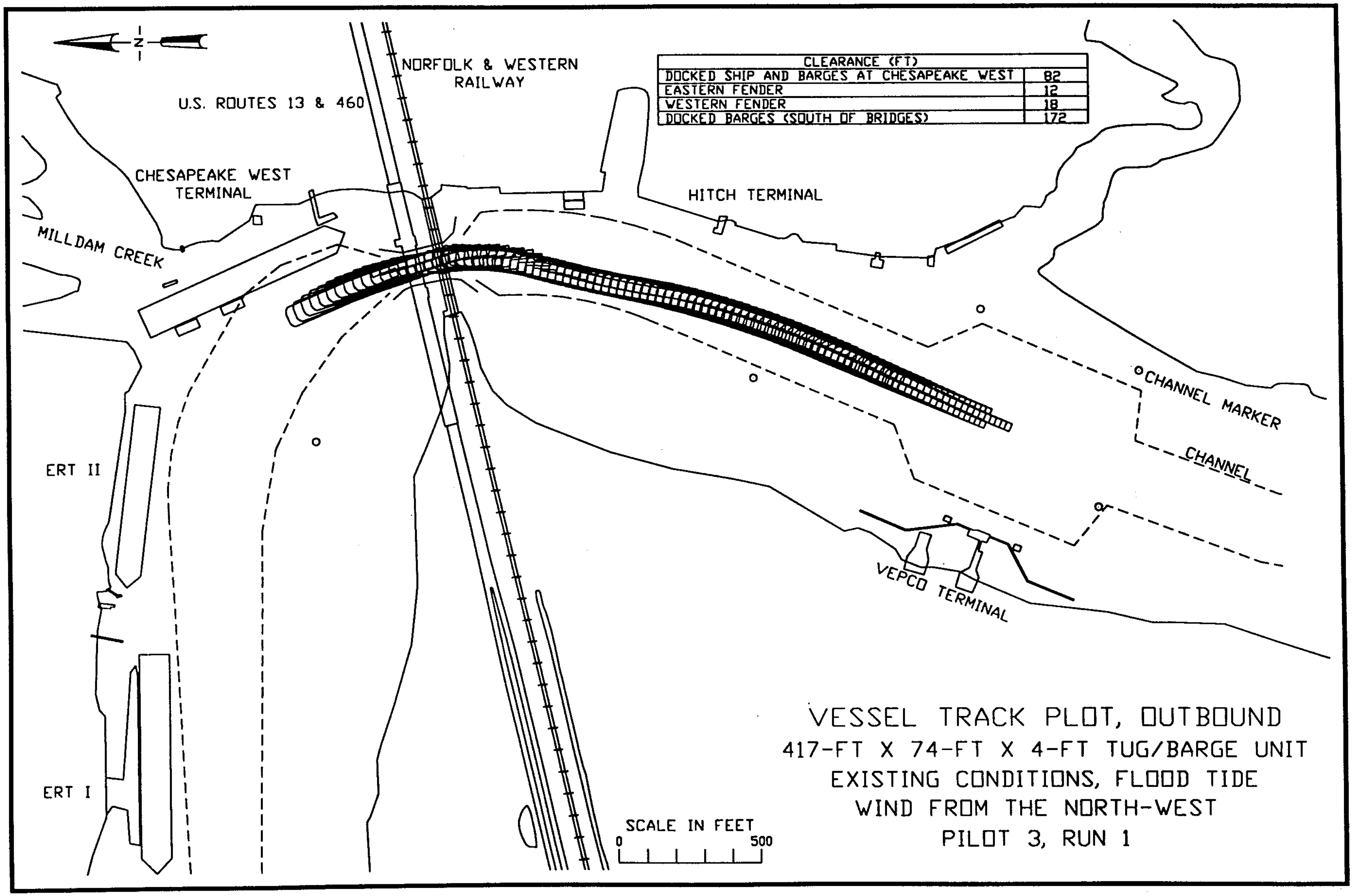

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 2, RUN 3
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST N/A
EASTERN FENDER 6
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 42
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
N
SCALE IN FEET
0
500

Plate 104



VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 3, RUN 1

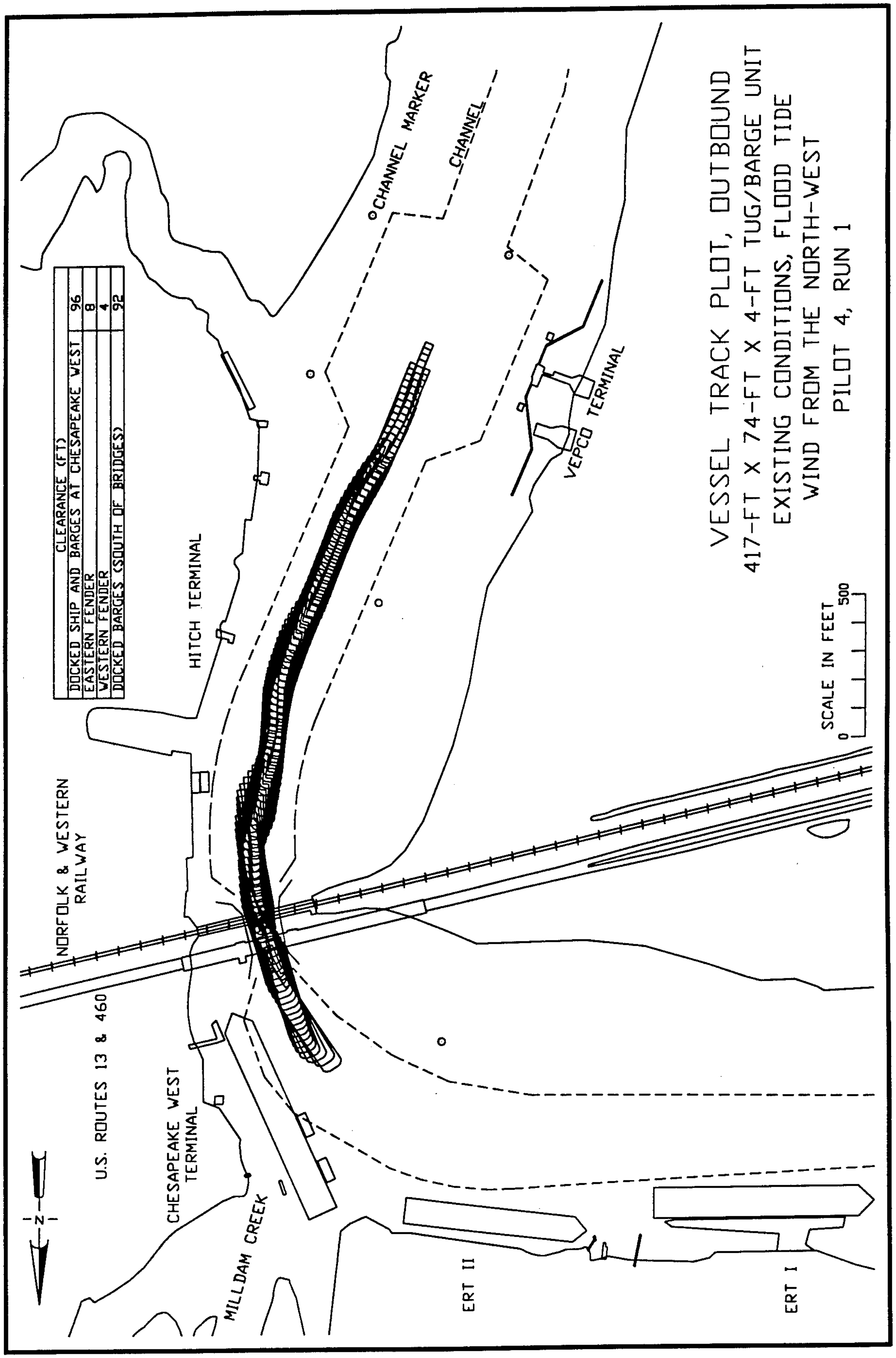

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 4, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 96
EASTERN FENDER 8
WESTERN FENDER 4
DOCKED BARGES (SOUTH OF BRIDGES) 92
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 106

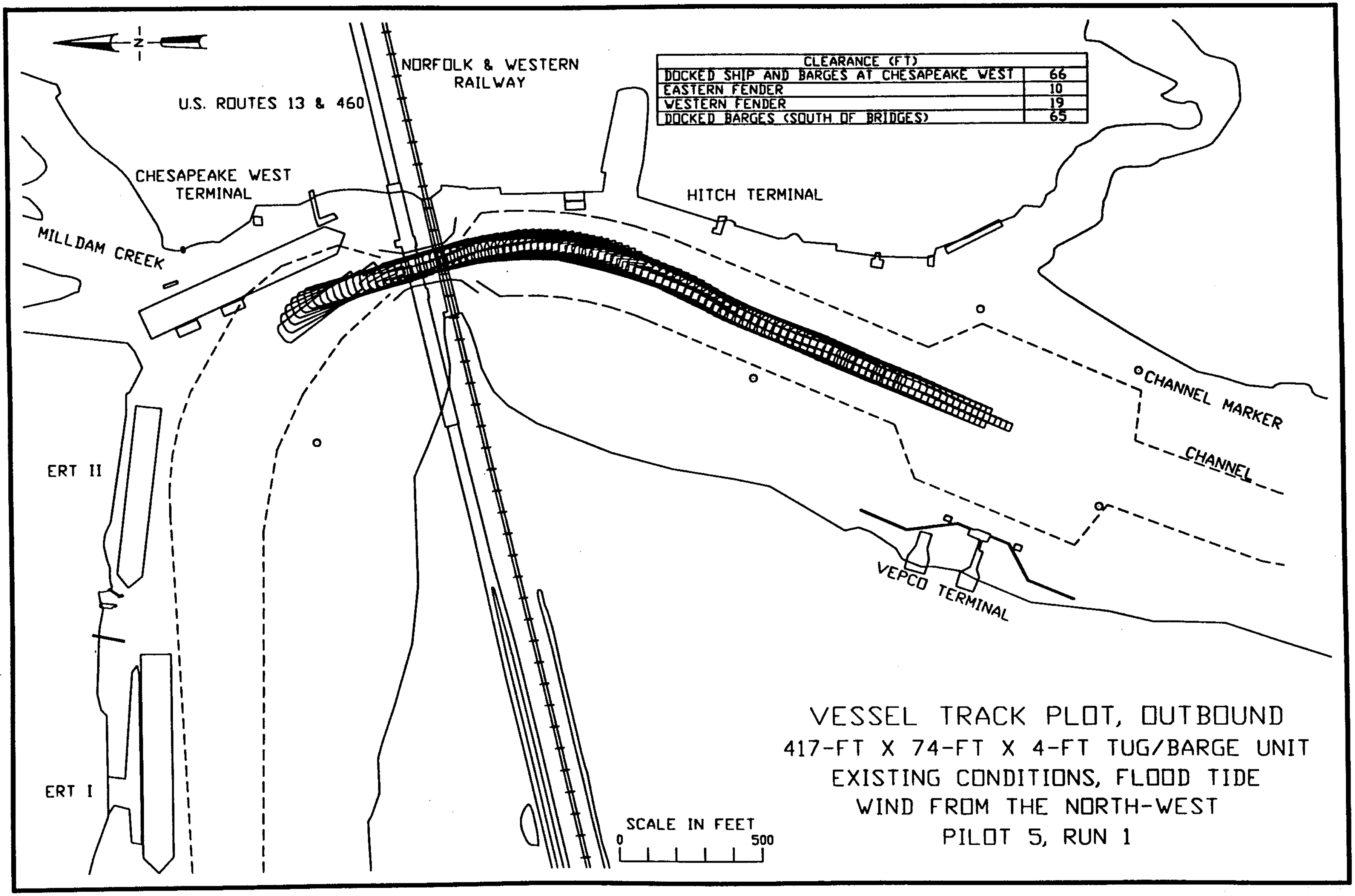

N
NORFOLK & WESTERN
RAILWAY
U.S. ROUTES 13 & 460
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 66
EASTERN FENDER 10
WESTERN FENDER 19
DOCKED BARGES (SOUTH OF BRIDGES) 65
CHESAPEAKE WEST
TERMINAL
HITCH TERMINAL
MILLDAM CREEK
CHANNEL MARKER
CHANNEL
ERT II
ERT I
VEPCO TERMINAL
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 5, RUN 1
SCALE IN FEET
0
500

Plate 107

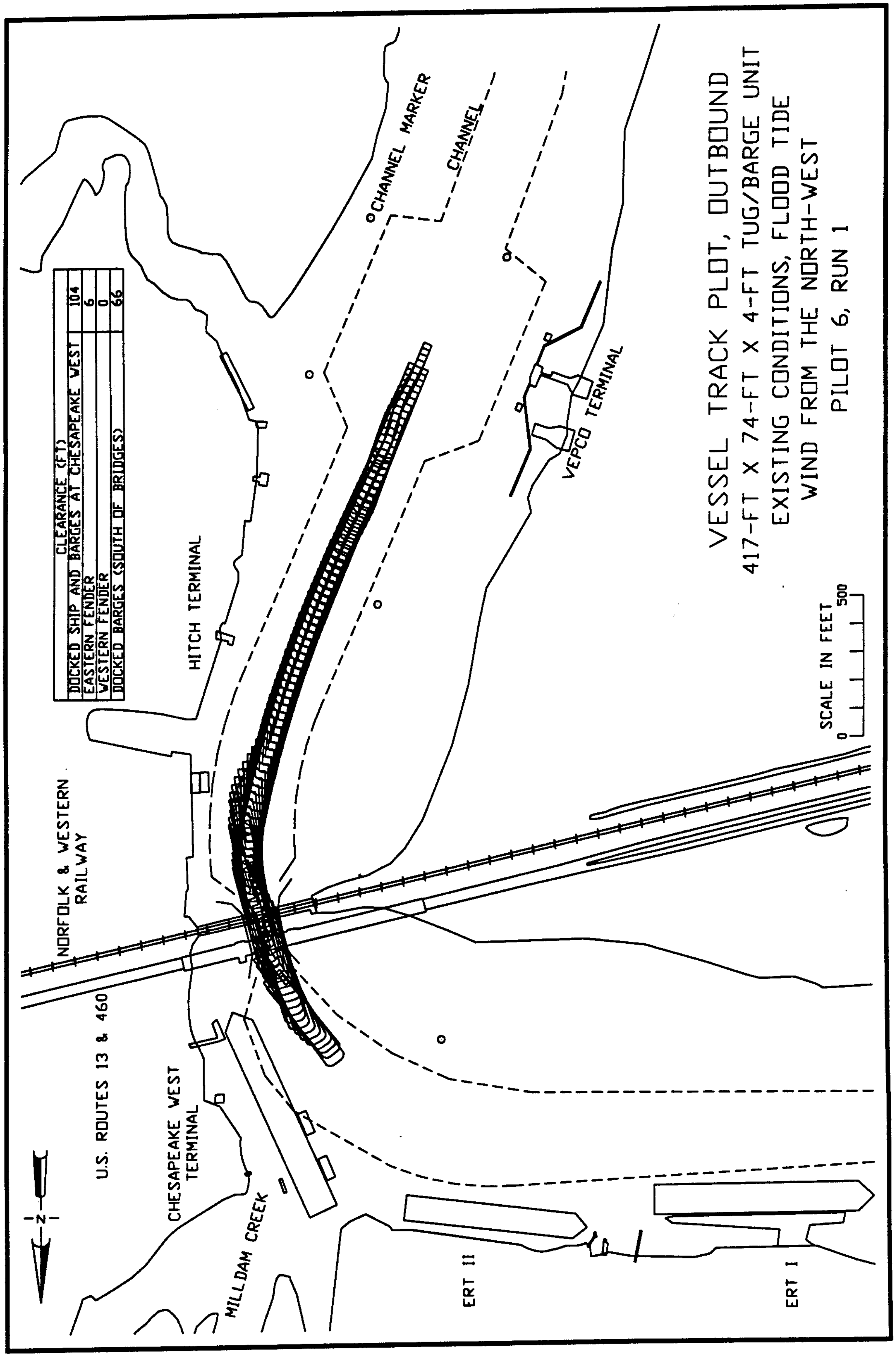
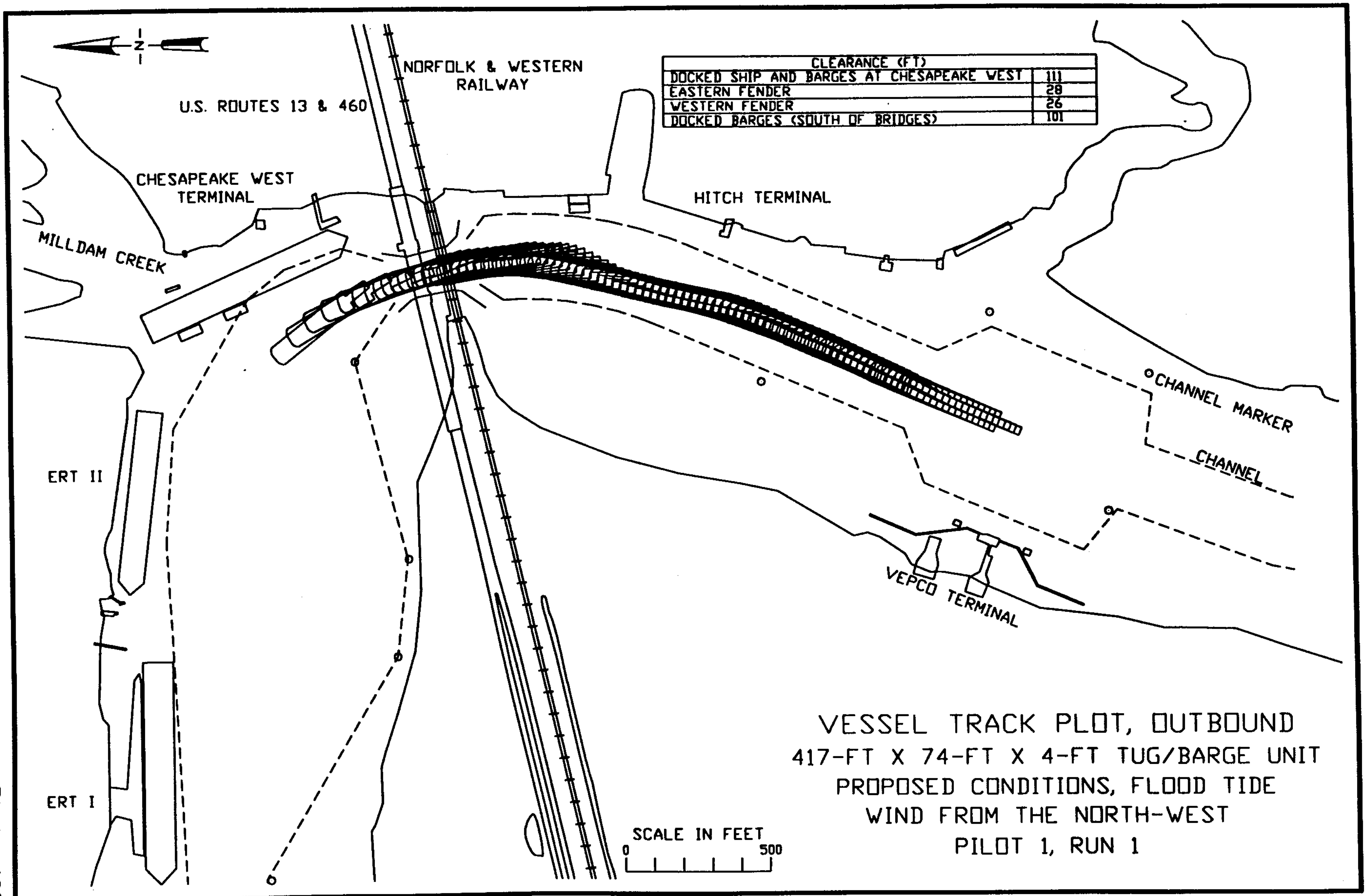
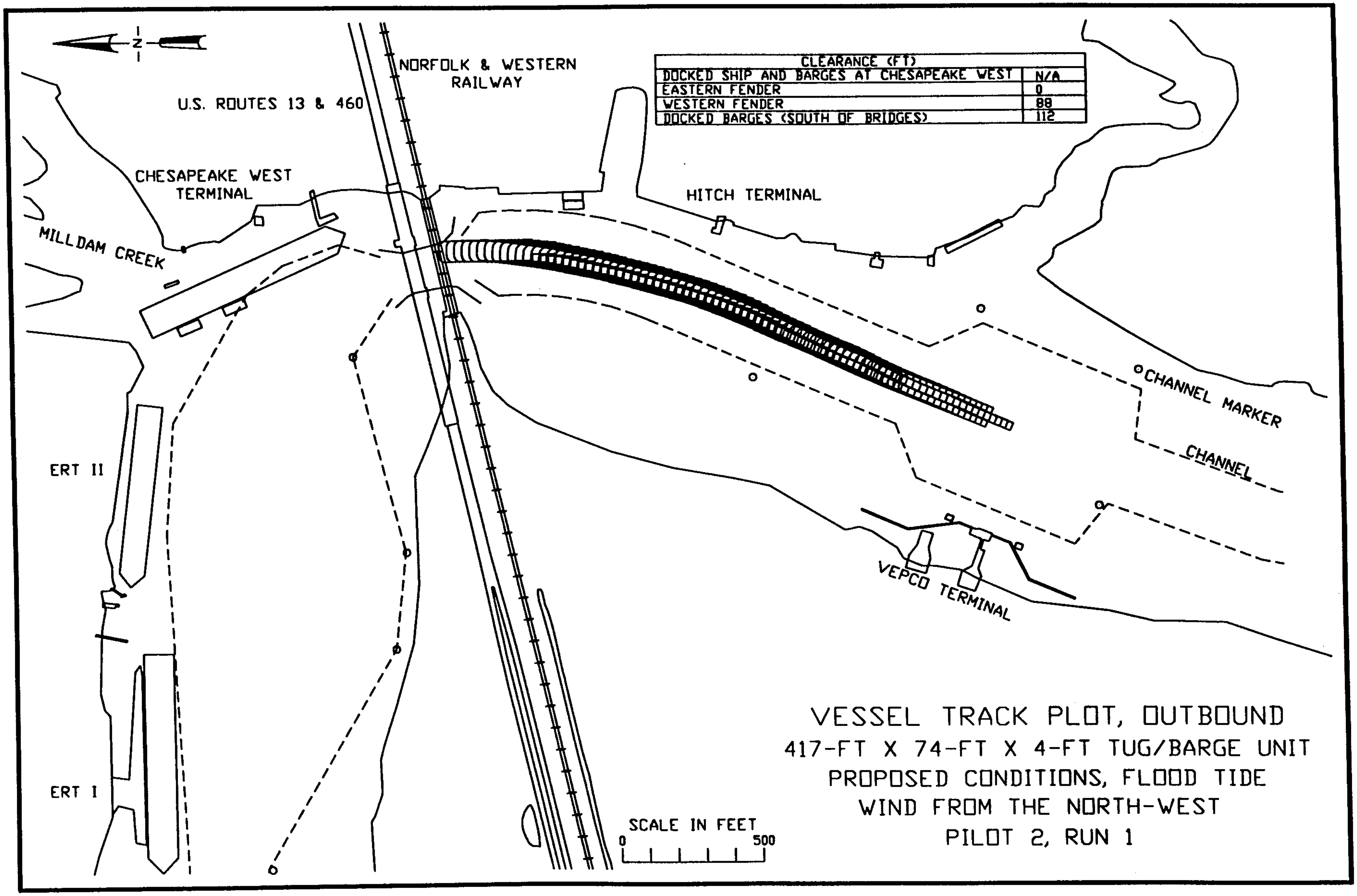

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 6, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 104
EASTERN FENDER 6
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 66
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 108



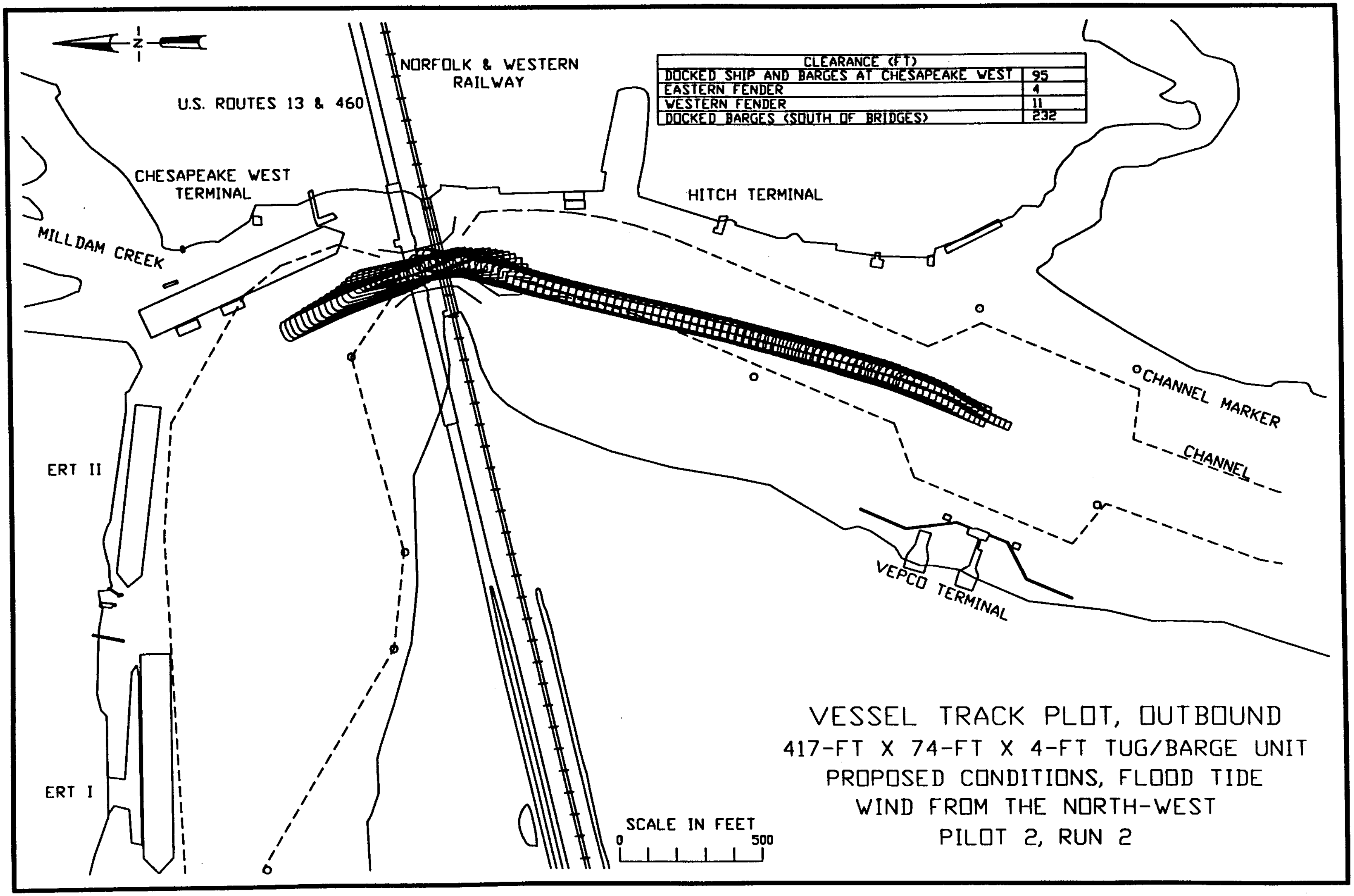
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 1, RUN 1

Plate 109



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	N/A
EASTERN FENDER	0
WESTERN FENDER	88
DOCKED BARGES (SOUTH OF BRIDGES)	112

Plate 110



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	95
EASTERN FENDER	4
WESTERN FENDER	11
DOCKED BARGES (SOUTH OF BRIDGES)	232

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 2, RUN 2

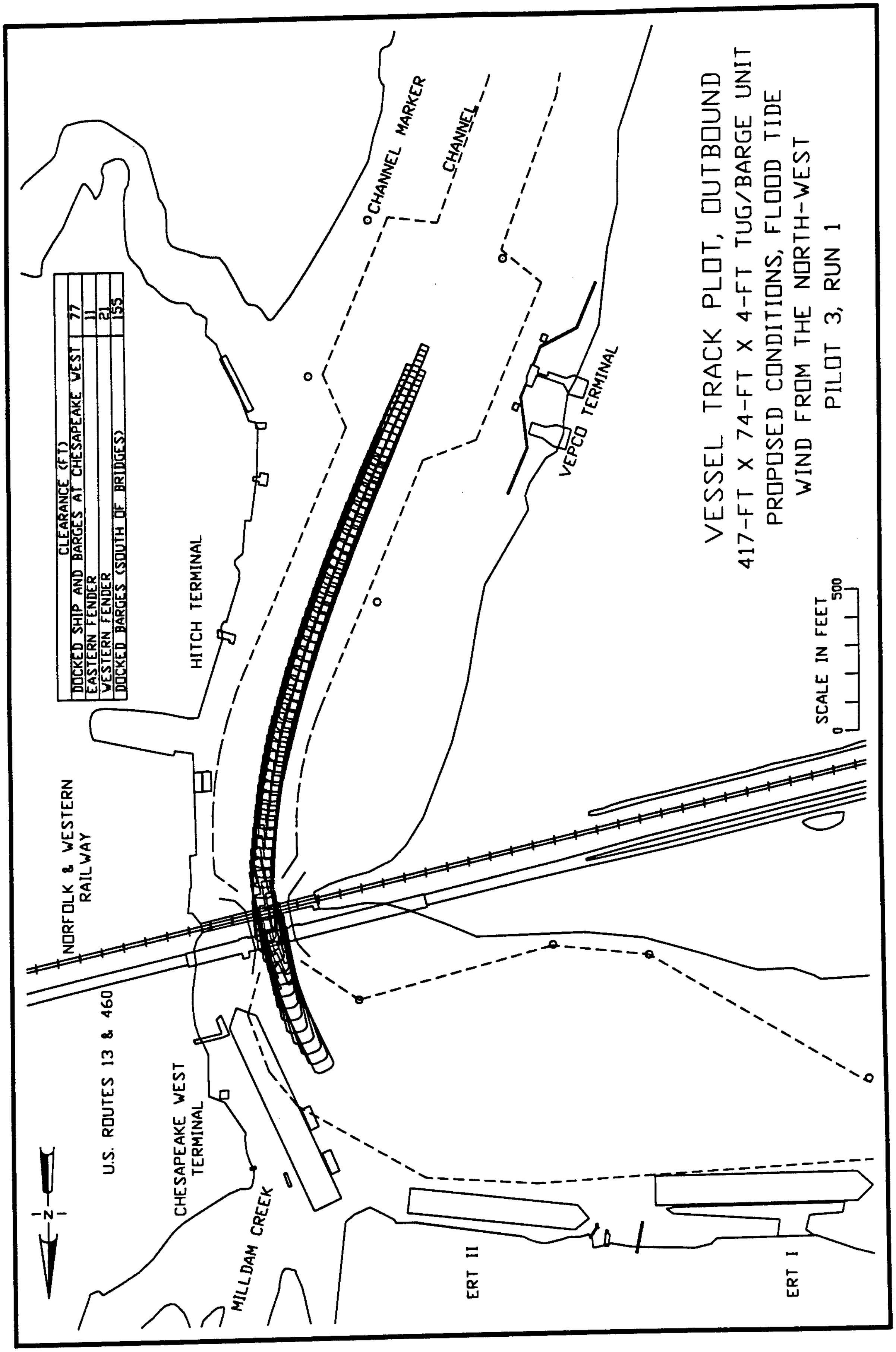
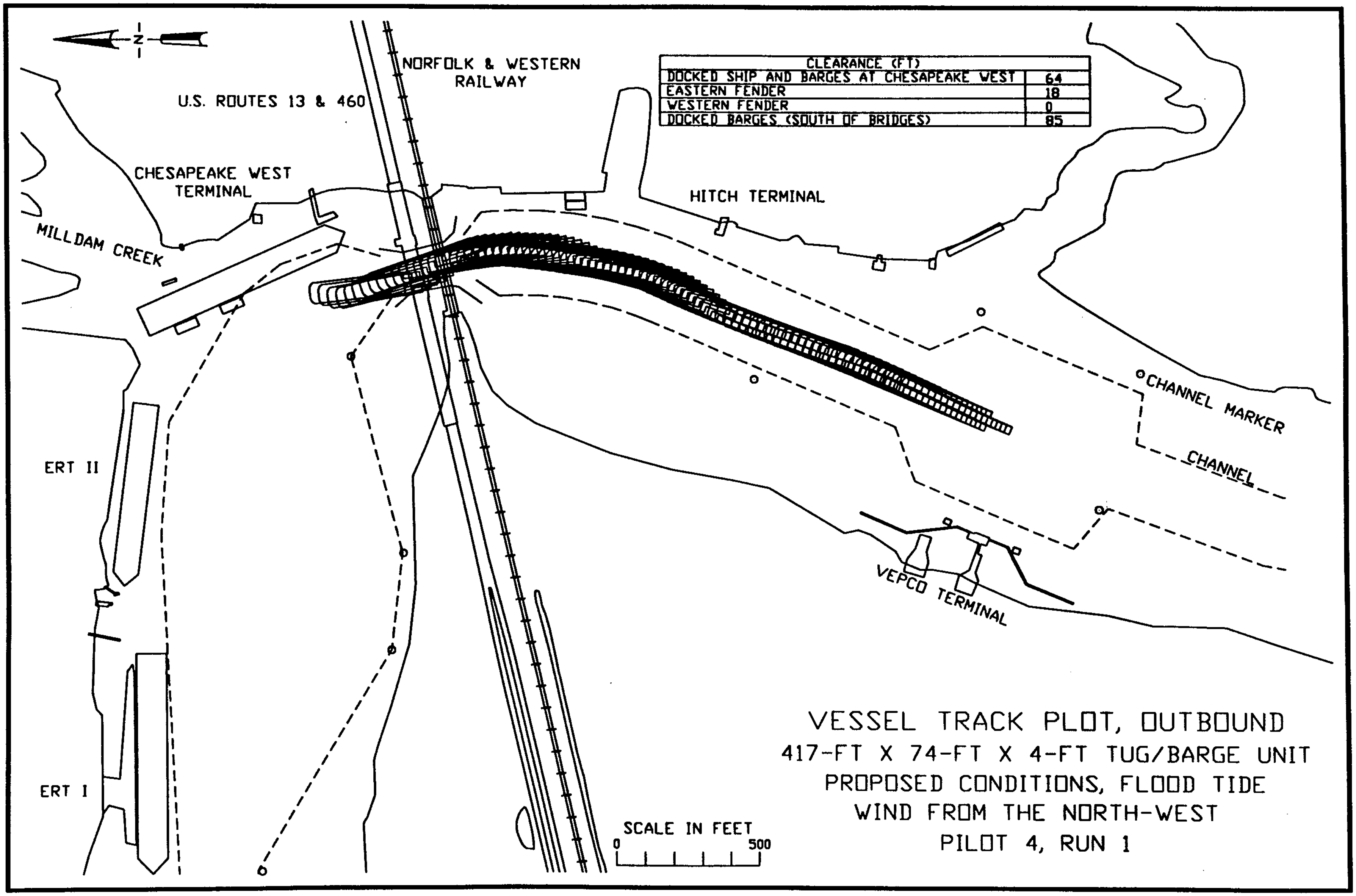

VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 3, RUN 1
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 77
EASTERN FENDER 11
WESTERN FENDER 21
DOCKED BARGES (SOUTH OF BRIDGES) 155
CHANNEL MARKER
CHANNEL
HITCH TERMINAL
VEPCO TERMINAL
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
ERT II
ERT I
SCALE IN FEET
0
500
N

Plate 112


N
NORFOLK & WESTERN RAILWAY
U.S. ROUTES 13 & 460
CHESAPEAKE WEST TERMINAL
MILLDAM CREEK
HITCH TERMINAL
CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 64
EASTERN FENDER 18
WESTERN FENDER 0
DOCKED BARGES (SOUTH OF BRIDGES) 85
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
ERT II
ERT I
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 4, RUN 1

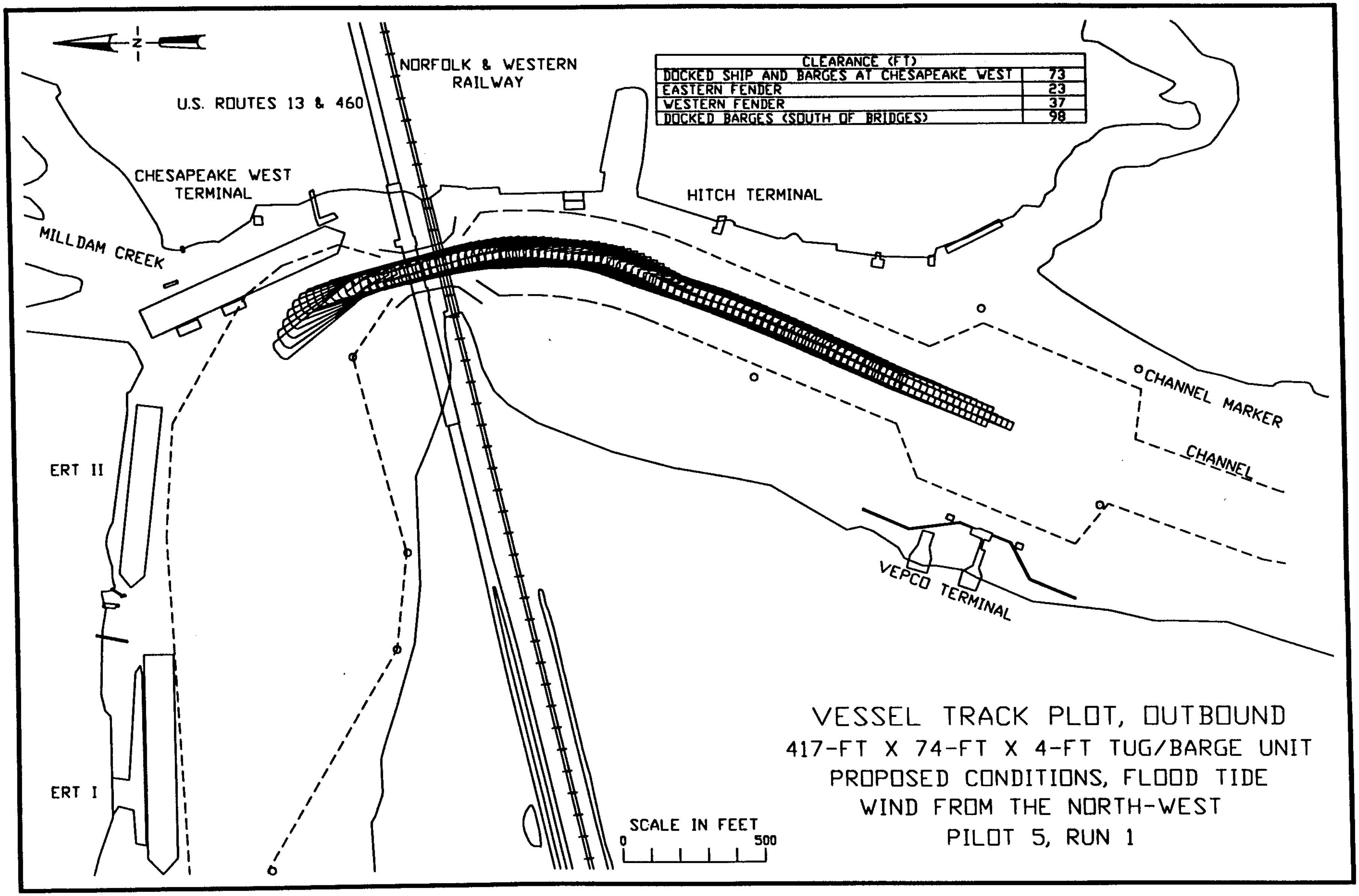
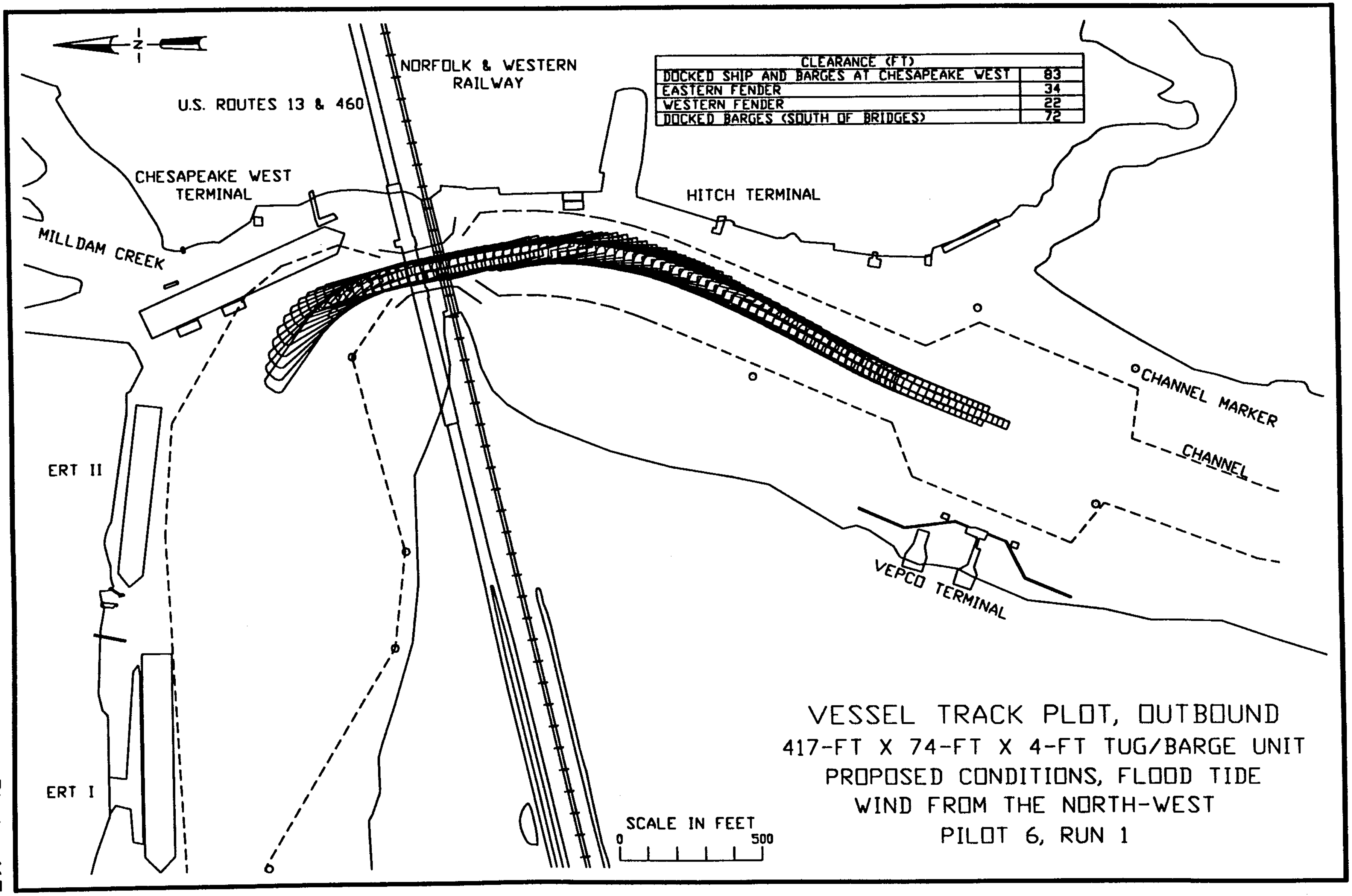
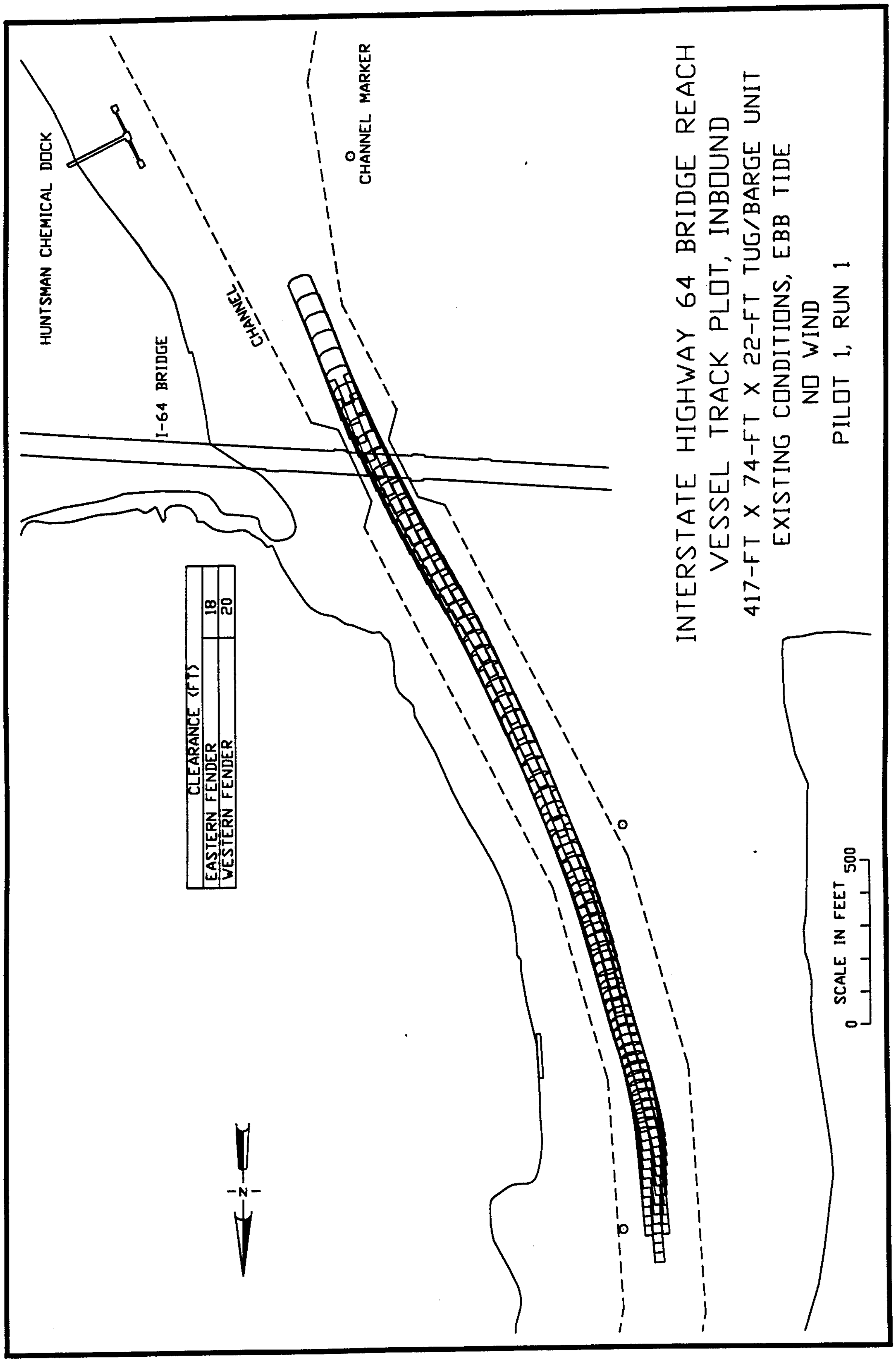

CLEARANCE (FT)
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST 73
EASTERN FENDER 23
WESTERN FENDER 37
DOCKED BARGES (SOUTH OF BRIDGES) 98
N
U.S. ROUTES 13 & 460
NORFOLK & WESTERN RAILWAY
CHESAPEAKE WEST TERMINAL
HITCH TERMINAL
MILLDAM CREEK
ERT II
ERT I
CHANNEL MARKER
CHANNEL
VEPCO TERMINAL
SCALE IN FEET
0
500
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 5, RUN 1

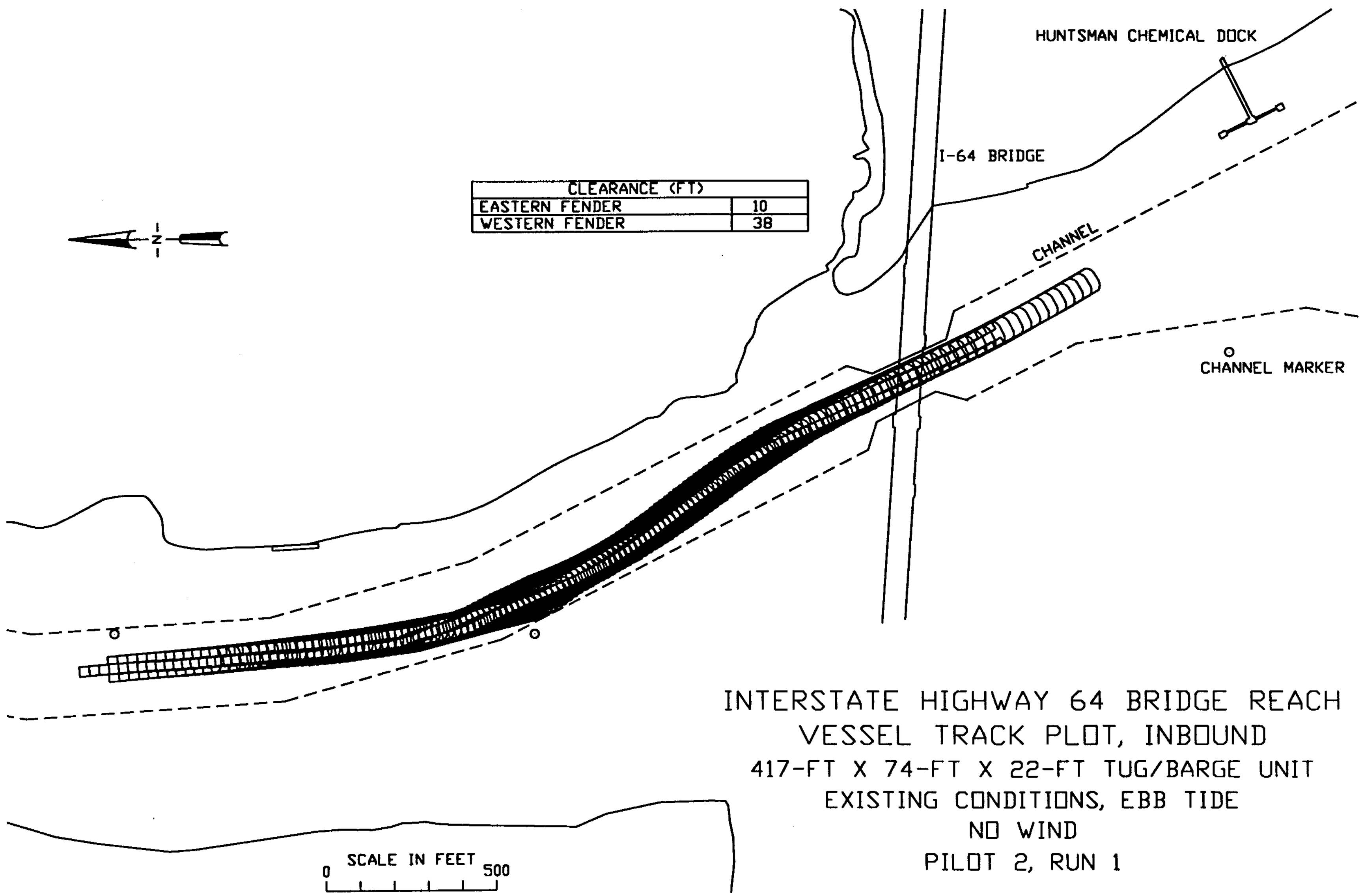
Plate 114



CLEARANCE (FT)	
DOCKED SHIP AND BARGES AT CHESAPEAKE WEST	83
EASTERN FENDER	34
WESTERN FENDER	22
DOCKED BARGES (SOUTH OF BRIDGES)	72

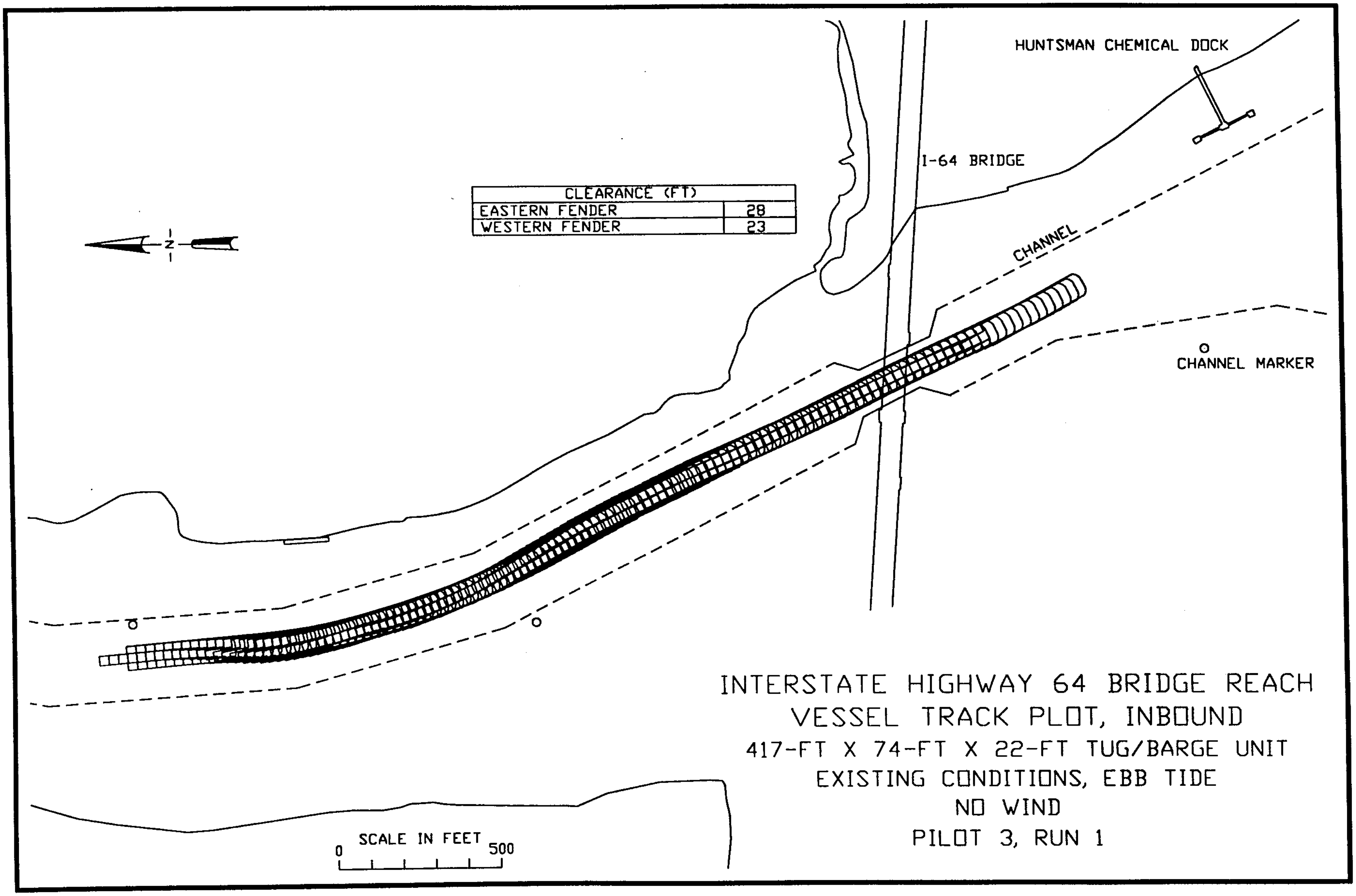
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PROPOSED CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-WEST
PILOT 6, RUN 1


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
NO WIND
PILOT 1, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 18
WESTERN FENDER 20
SCALE IN FEET
0
500
N

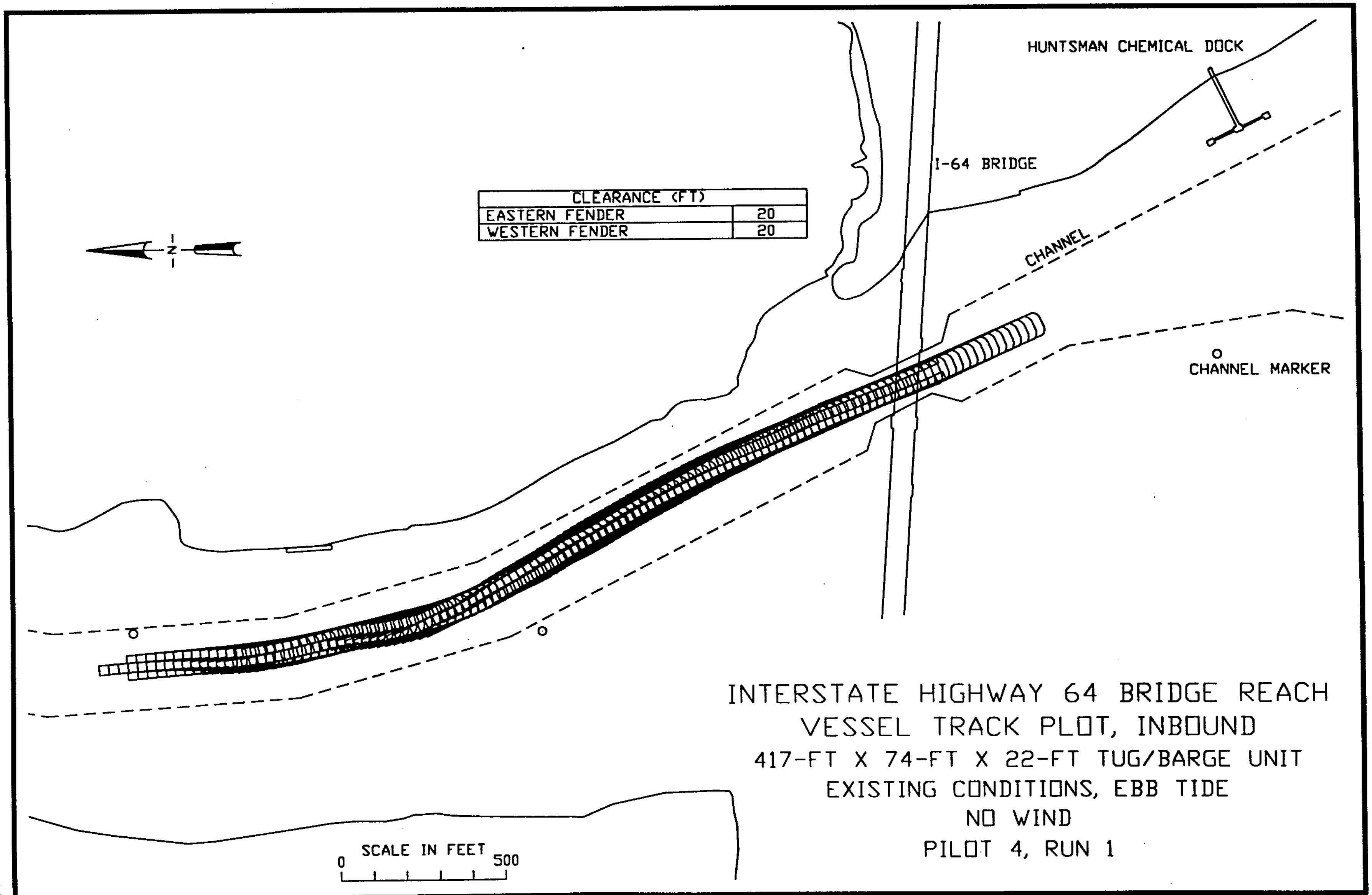


CLEARANCE (FT)	
EASTERN FENDER	10
WESTERN FENDER	38

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
NO WIND
PILOT 2, RUN 1

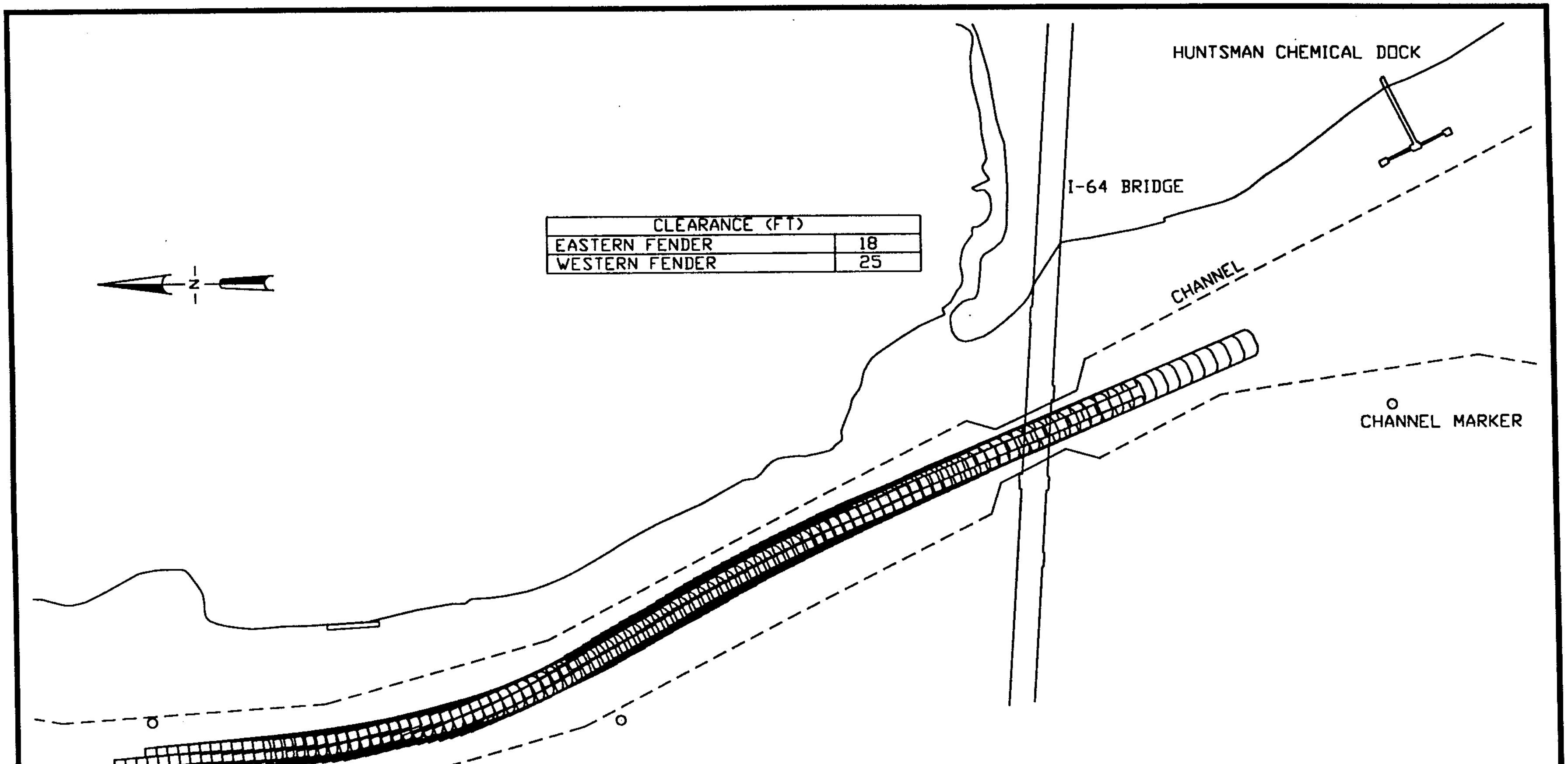


CLEARANCE (FT)	
EASTERN FENDER	28
WESTERN FENDER	23



CLEARANCE (FT)	
EASTERN FENDER	20
WESTERN FENDER	20

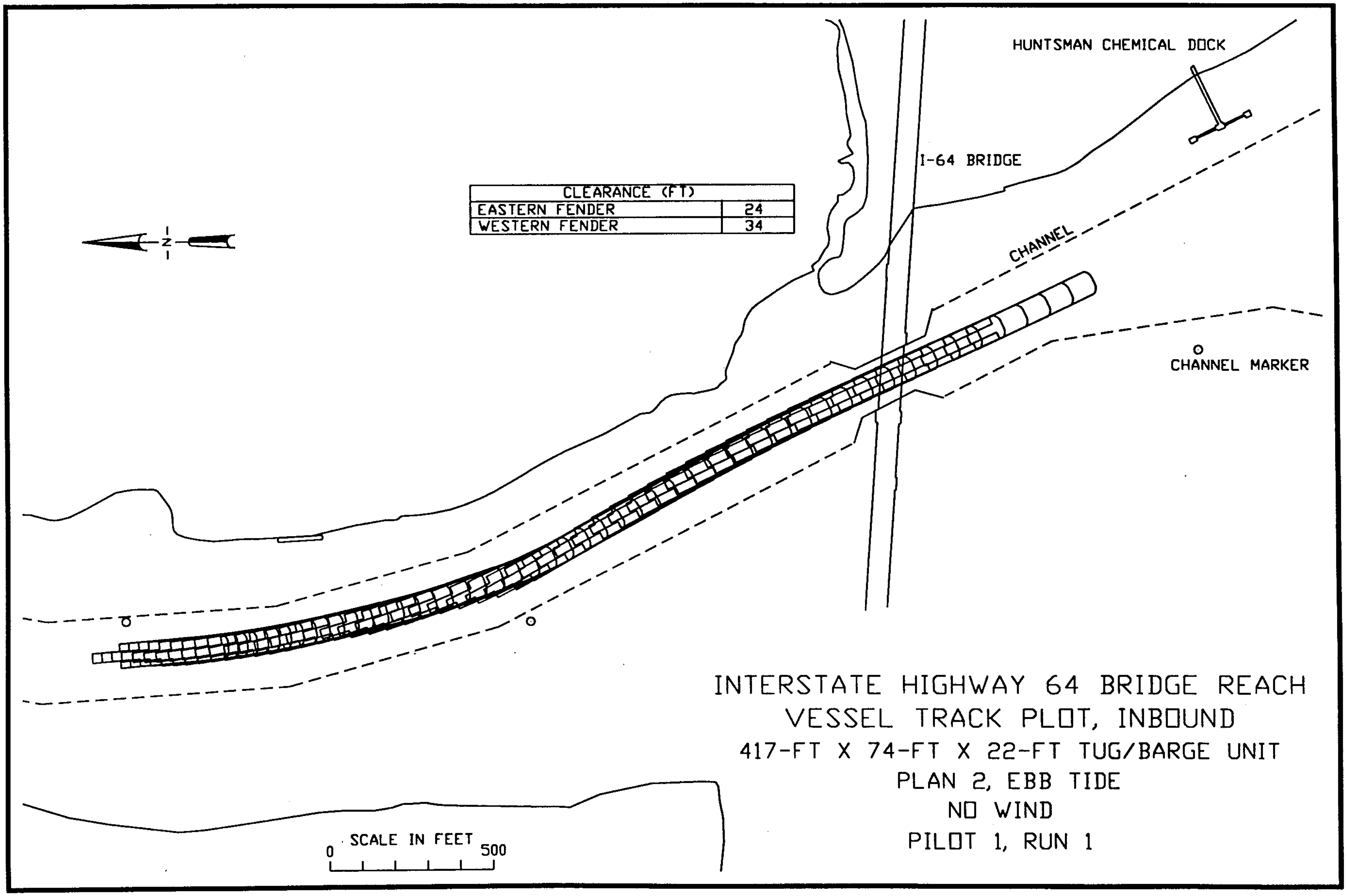
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
NO WIND
PILOT 4, RUN 1



CLEARANCE (FT)	
EASTERN FENDER	18
WESTERN FENDER	25

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
NO WIND
PILOT 5, RUN 1

Plate 120


HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 24
WESTERN FENDER 34
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
NO WIND
PILOT 1, RUN 1

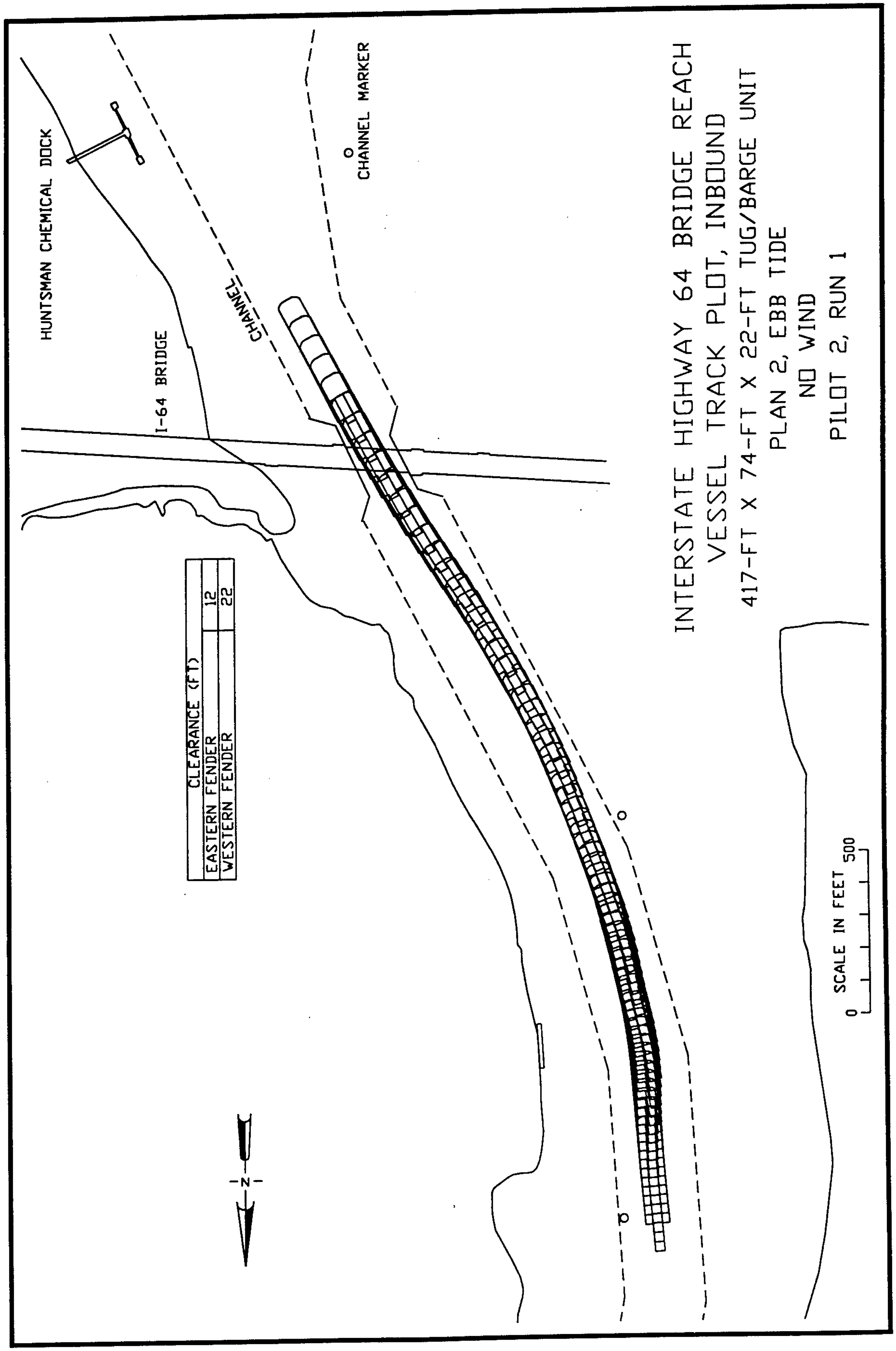
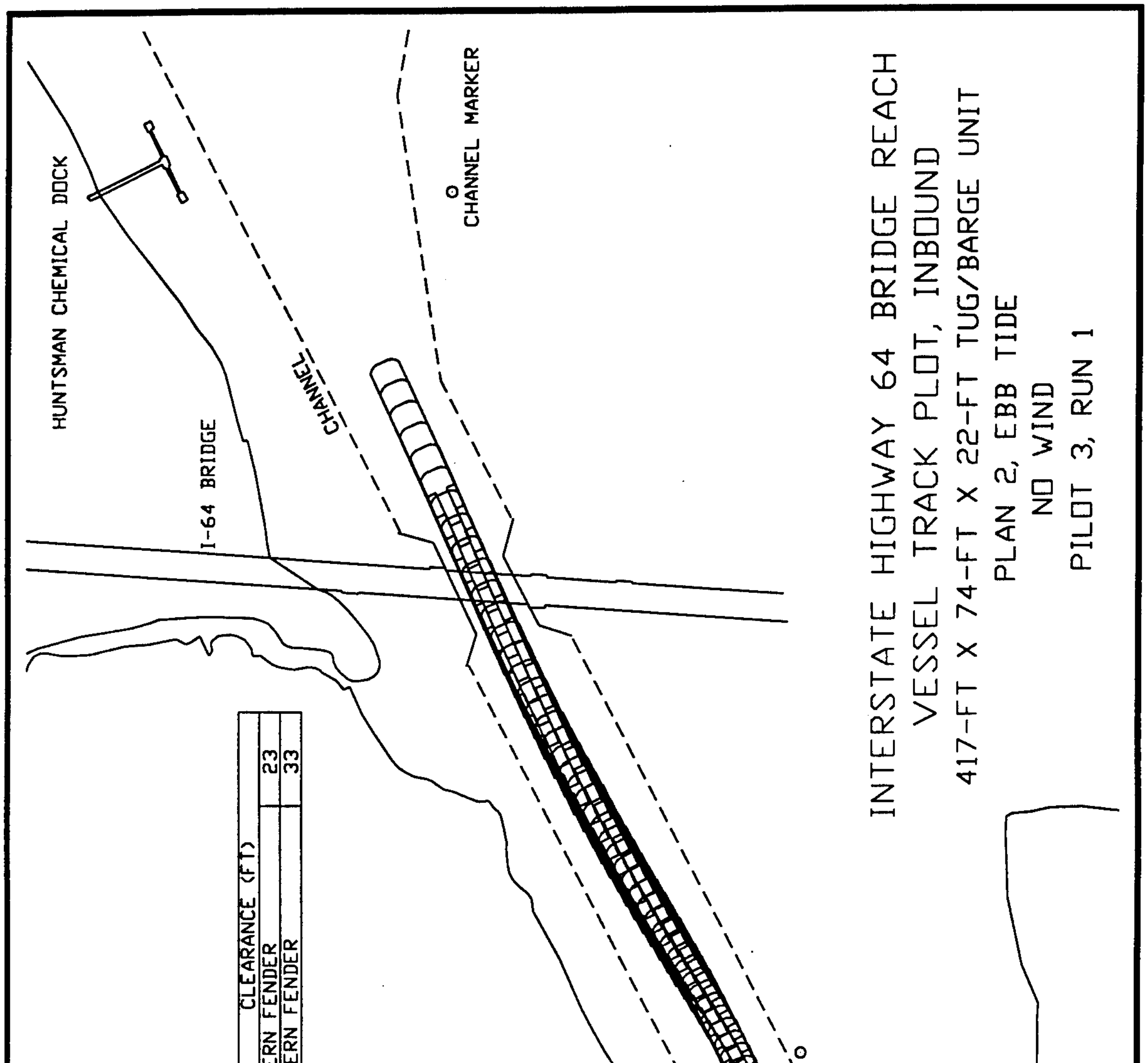
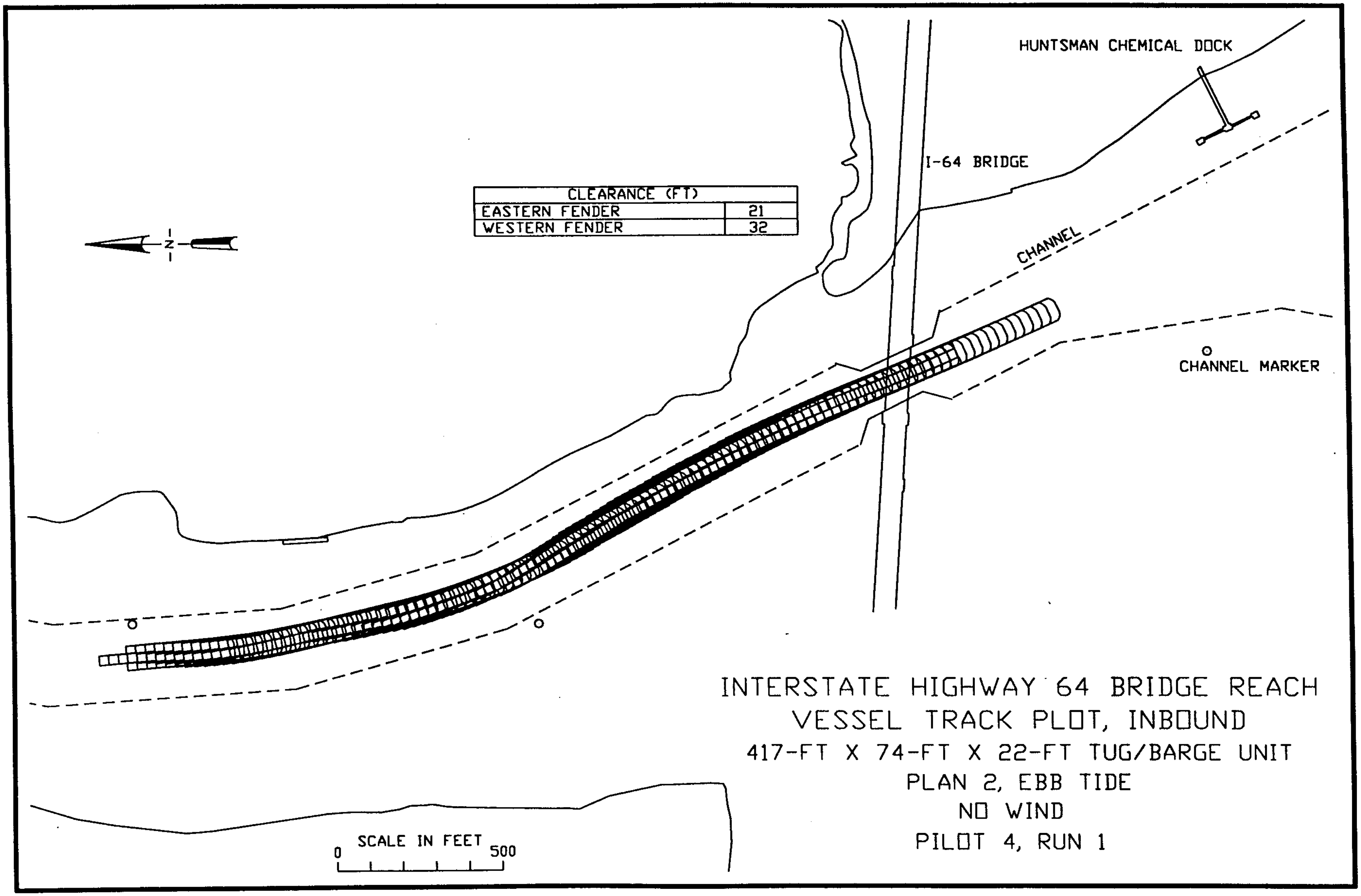

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
NO WIND
PILOT 2, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 12
WESTERN FENDER 22
N
SCALE IN FEET
0
500

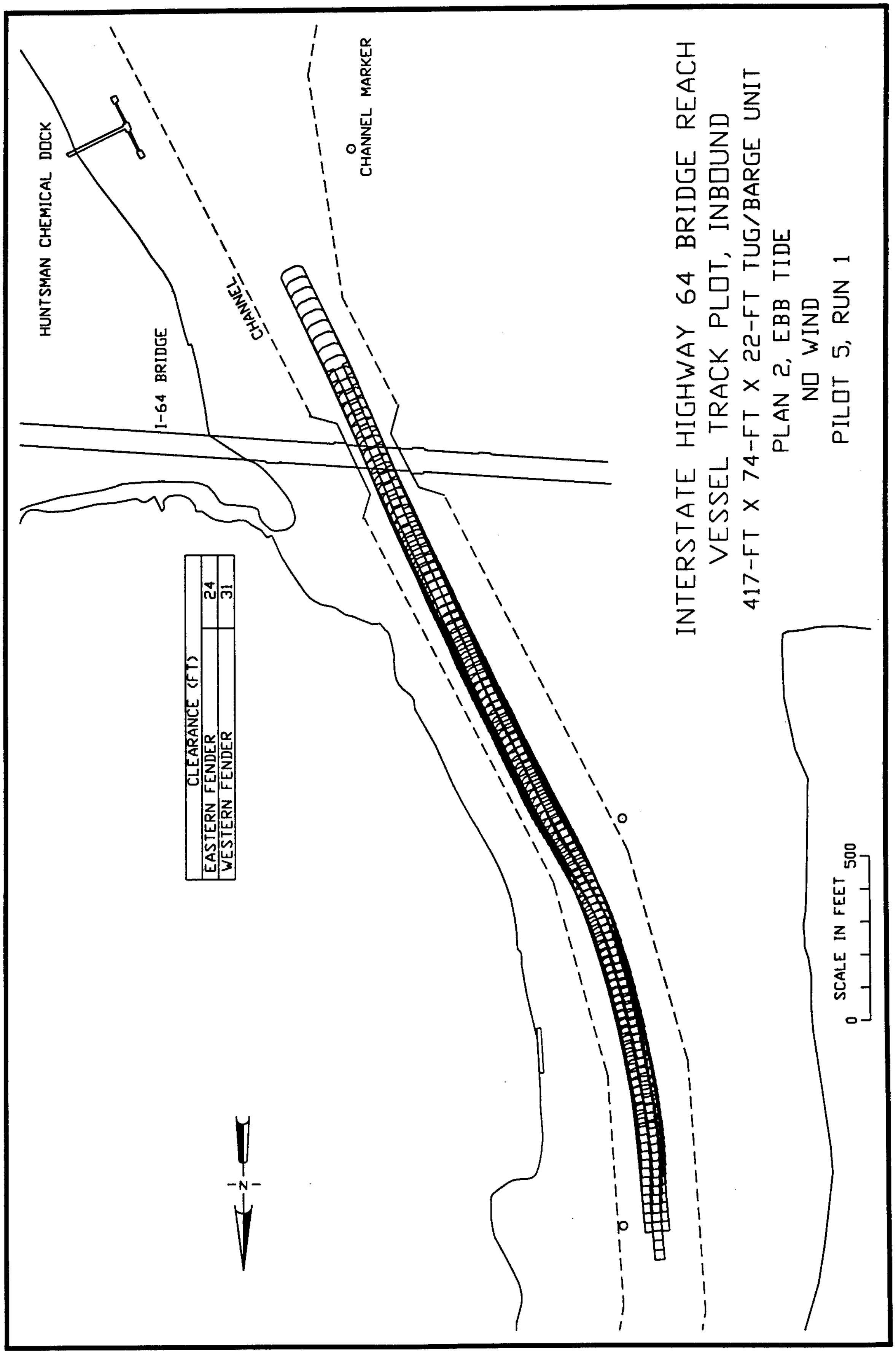
Plate 122

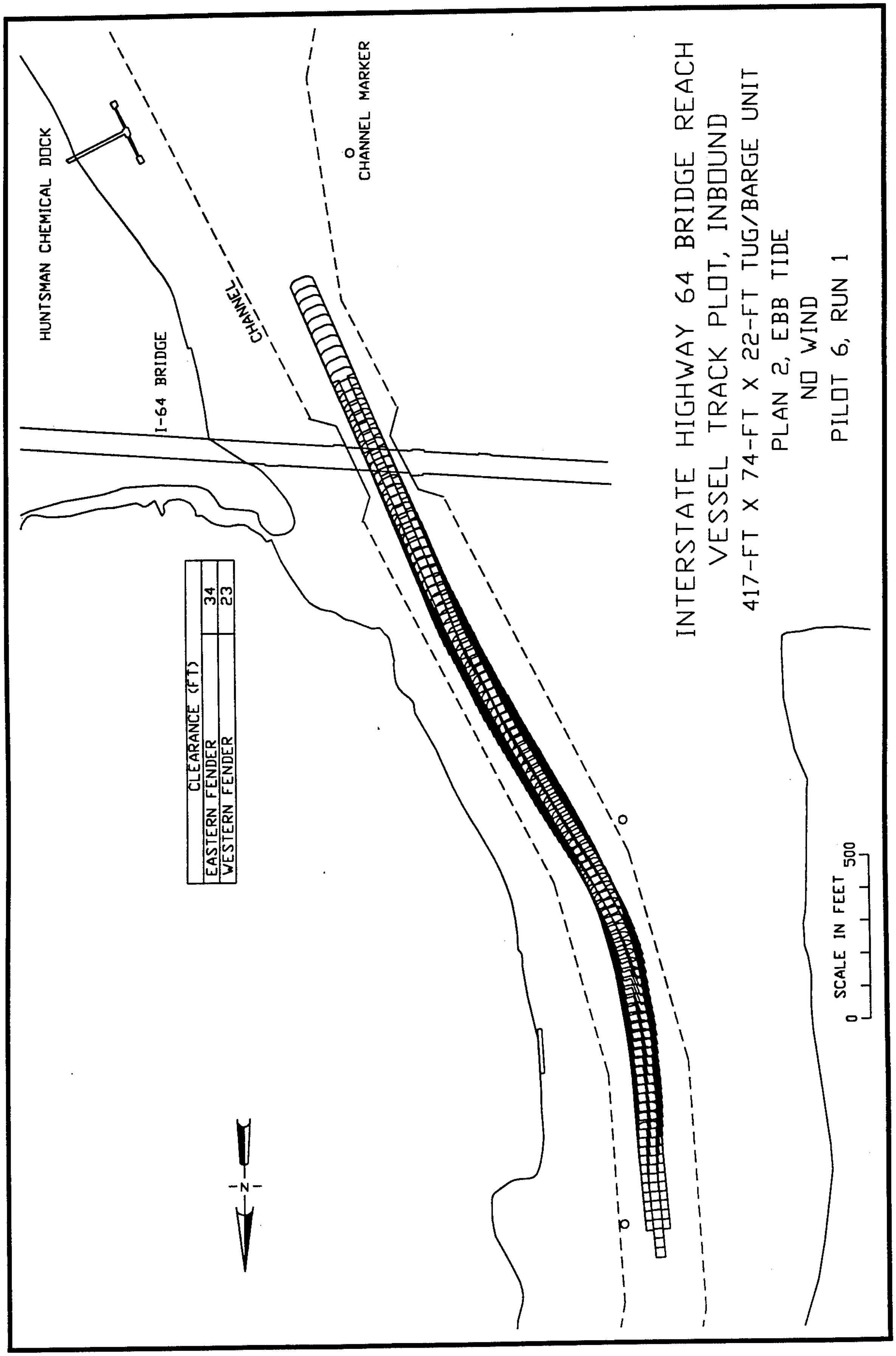

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
NO WIND
PILOT 3, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 23
WESTERN FENDER 33
N
SCALE IN FEET
0
500



CLEARANCE (FT)	
EASTERN FENDER	21
WESTERN FENDER	32

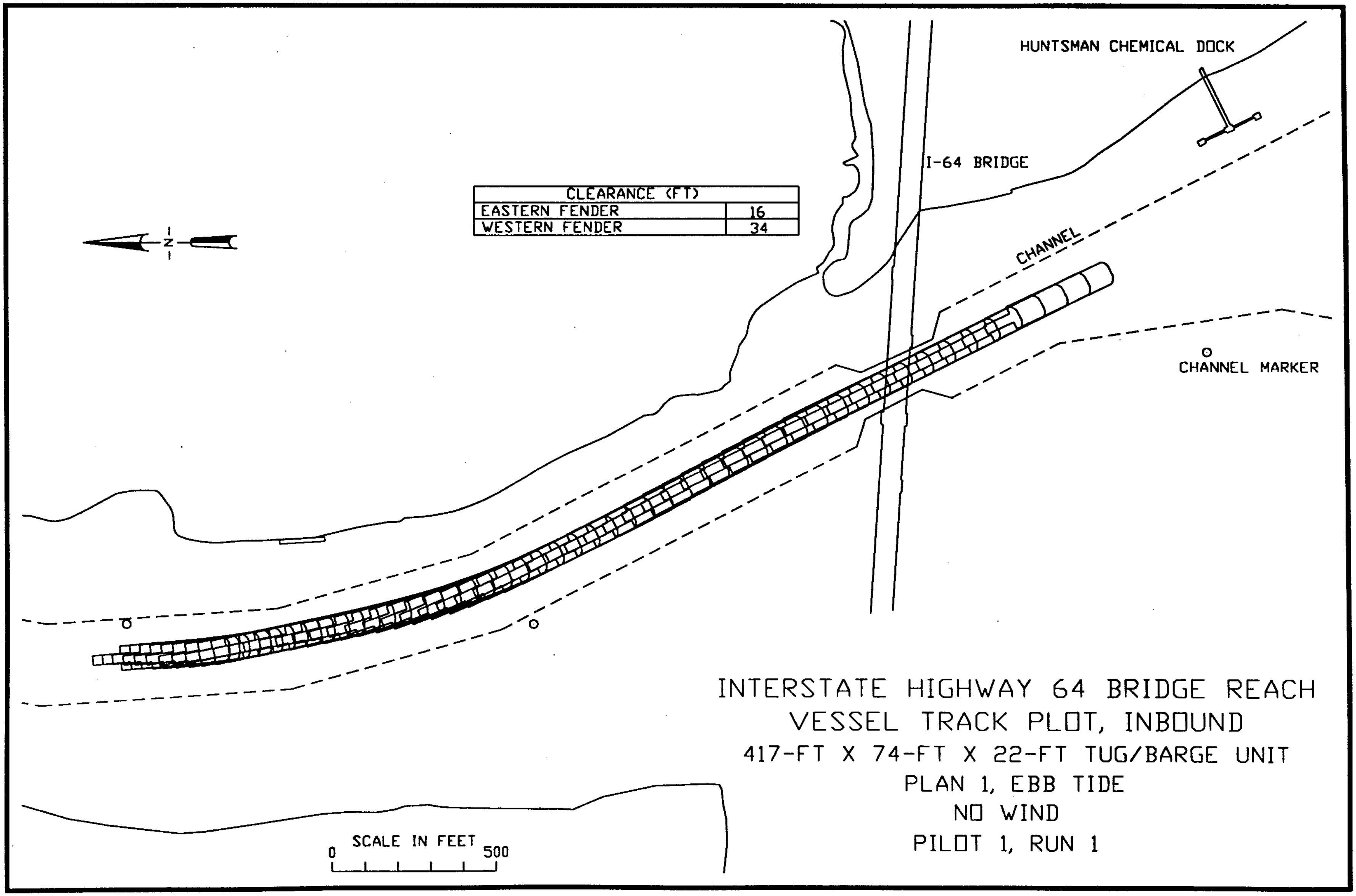
Plate 124


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
NO WIND
PILOT 5, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 24
WESTERN FENDER 31
SCALE IN FEET
0
500
N



INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
NO WIND
PILOT 6, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
I-64 BRIDGE
CHANNEL
CLEARANCE (FT)
EASTERN FENDER 34
WESTERN FENDER 23
SCALE IN FEET
0
500
N

Plate 126



CLEARANCE (FT)	
EASTERN FENDER	16
WESTERN FENDER	34

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
NO WIND
PILOT 1, RUN 1

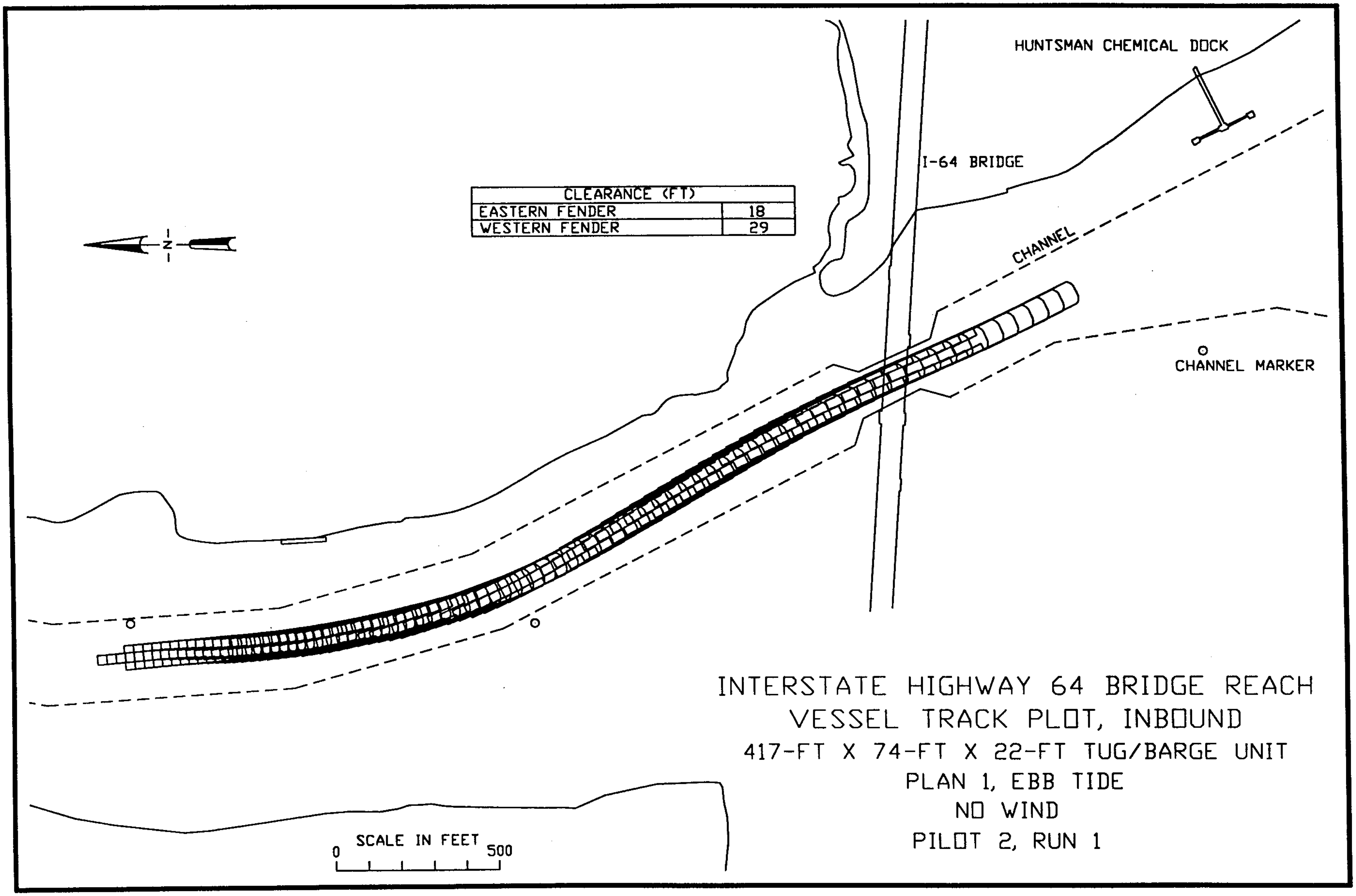
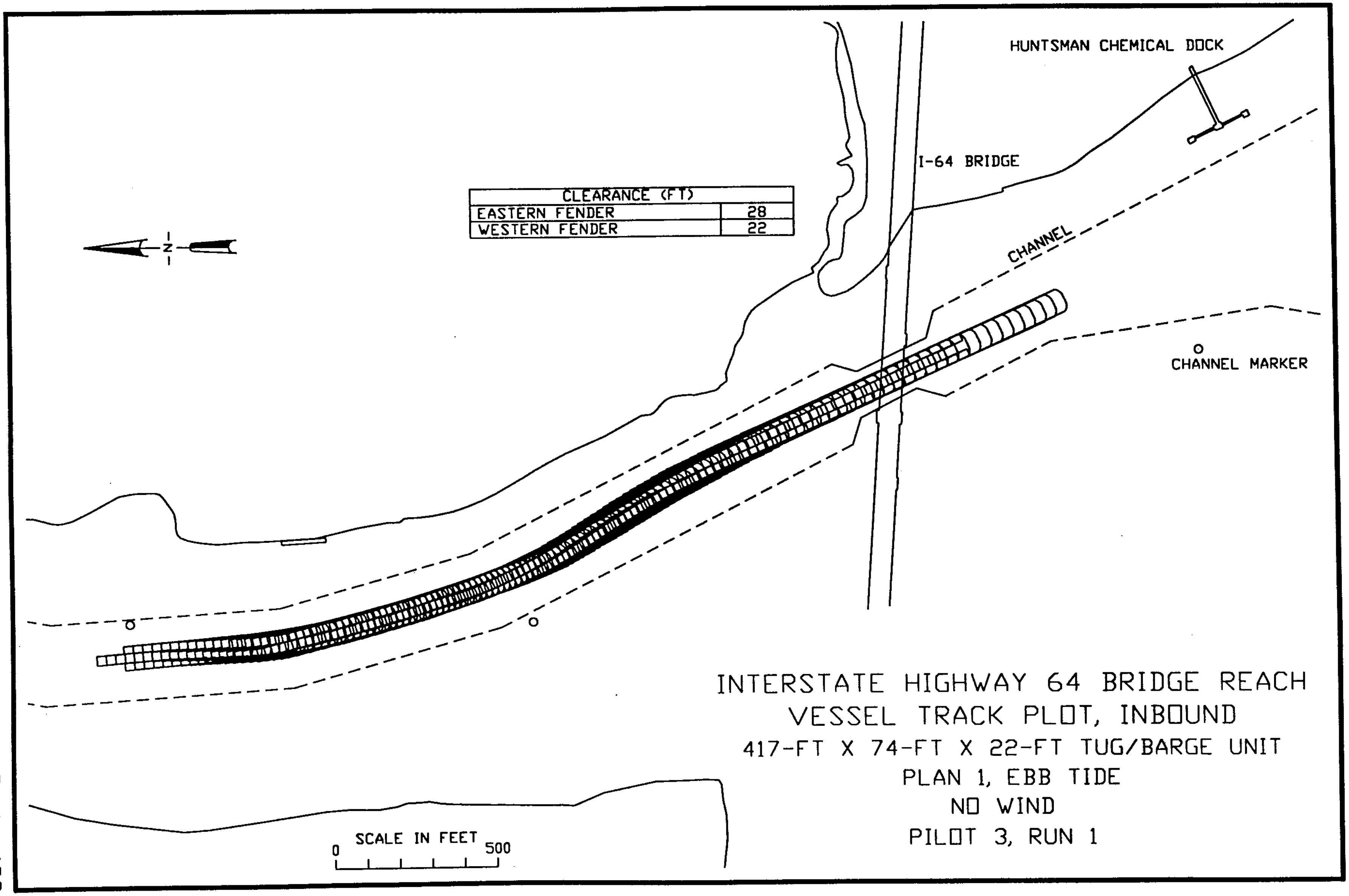

HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 18
WESTERN FENDER 29
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
NO WIND
PILOT 2, RUN 1

Plate 128


HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 28
WESTERN FENDER 22
N
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
NO WIND
PILOT 3, RUN 1
SCALE IN FEET
0
500

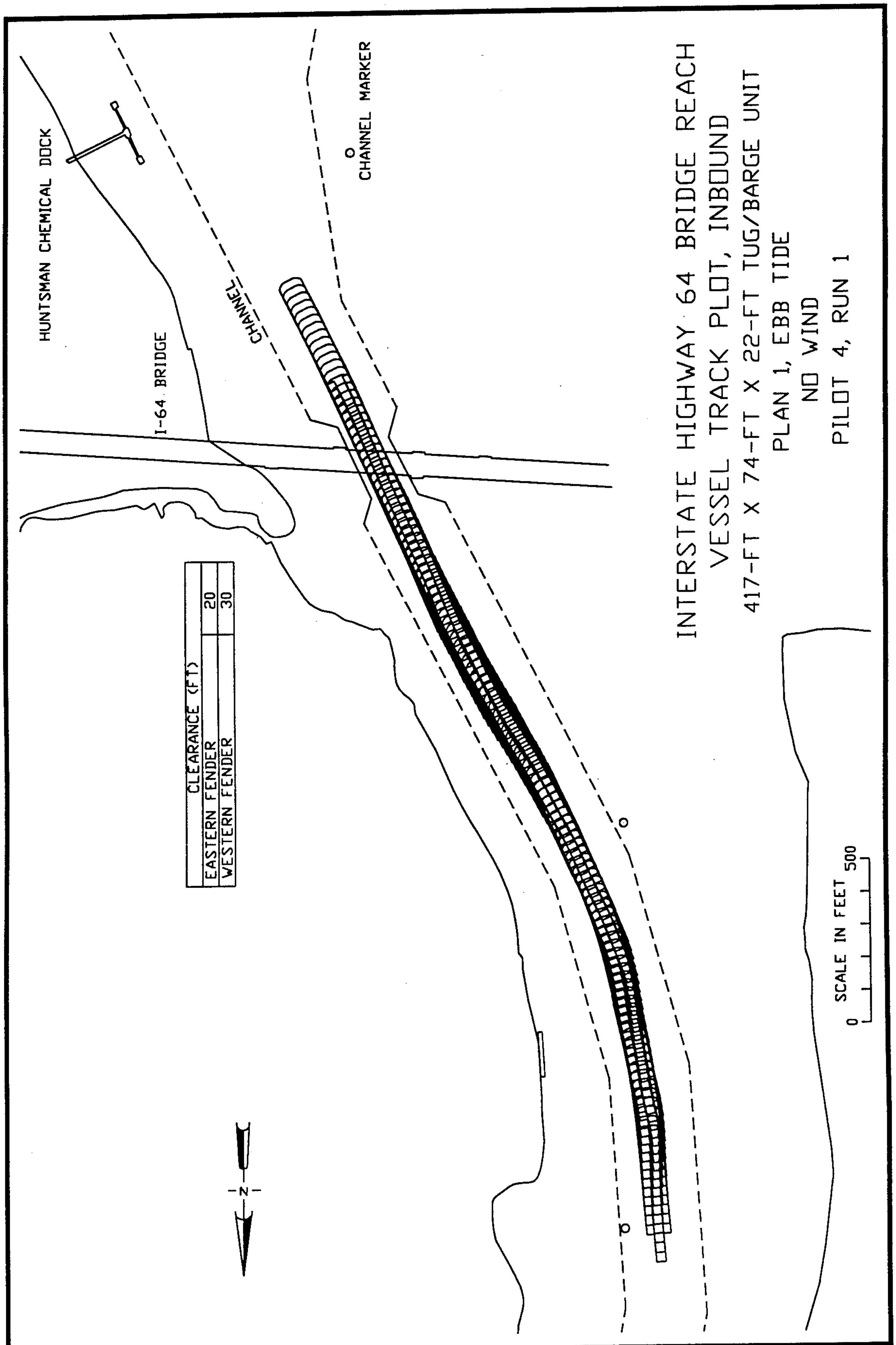
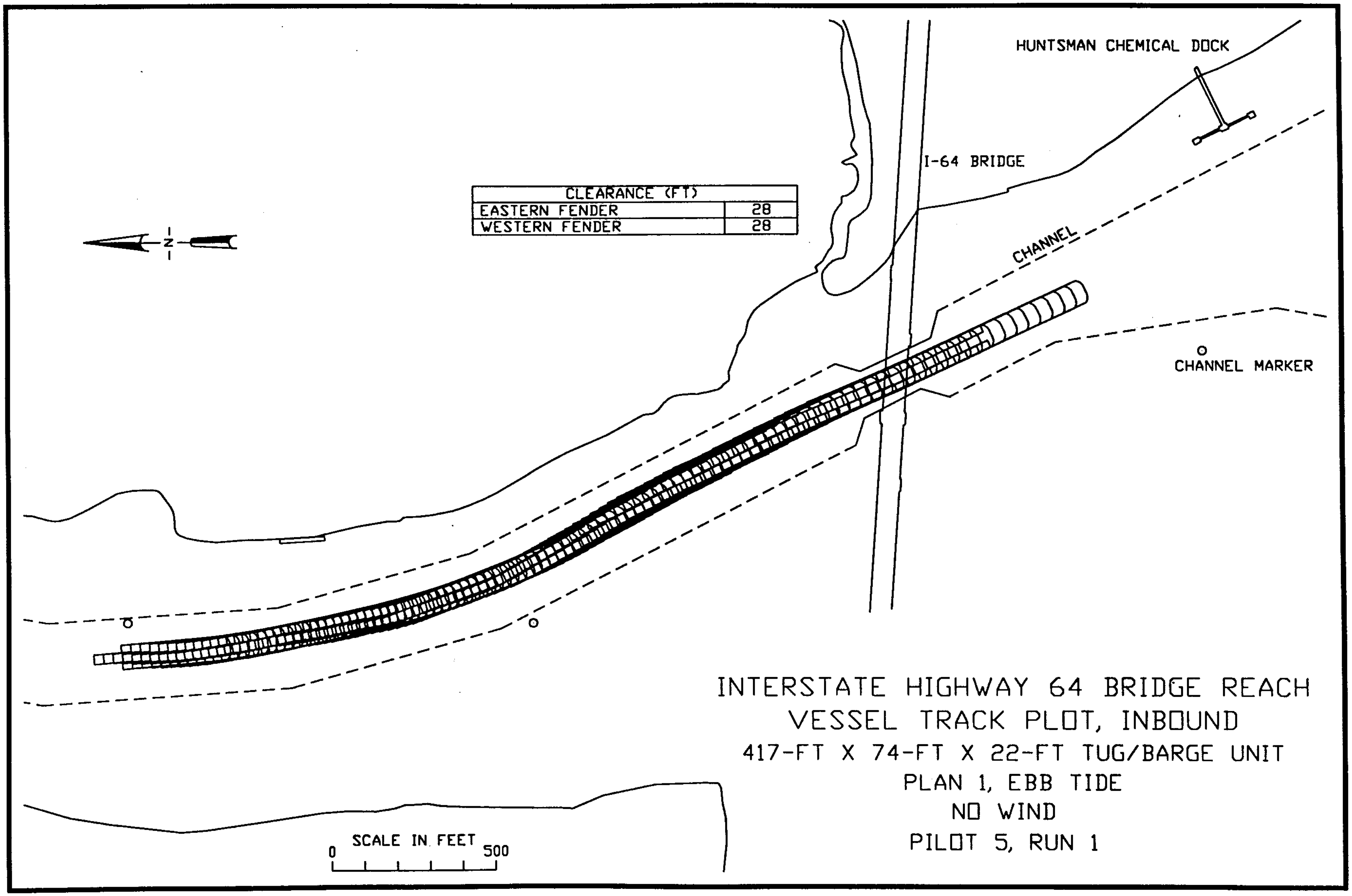
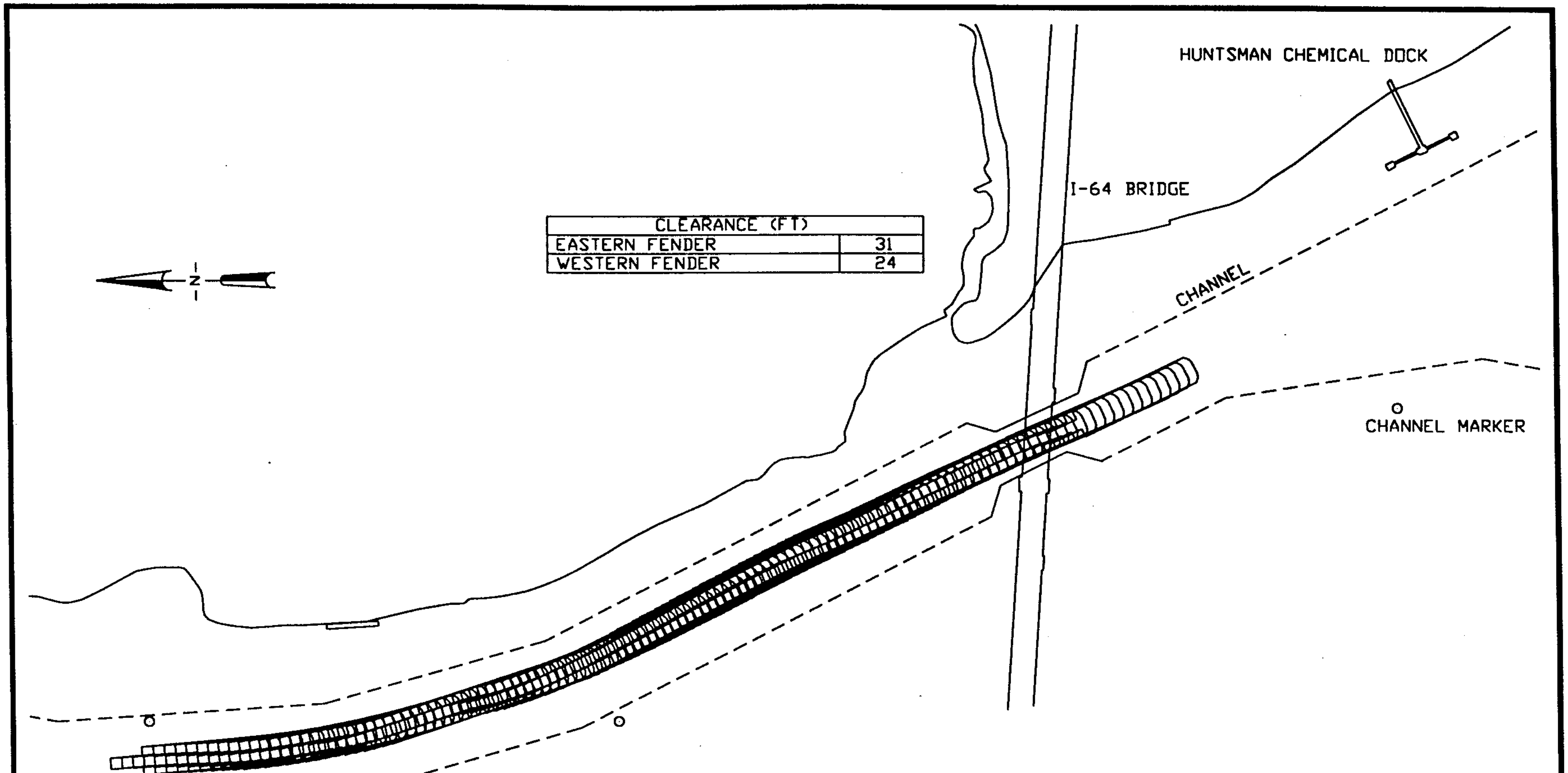

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
NO WIND
PILOT 4, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
I-64 BRIDGE
CHANNEL
CLEARANCE (FT)
EASTERN FENDER 20
WESTERN FENDER 30
SCALE IN FEET
0
500
N

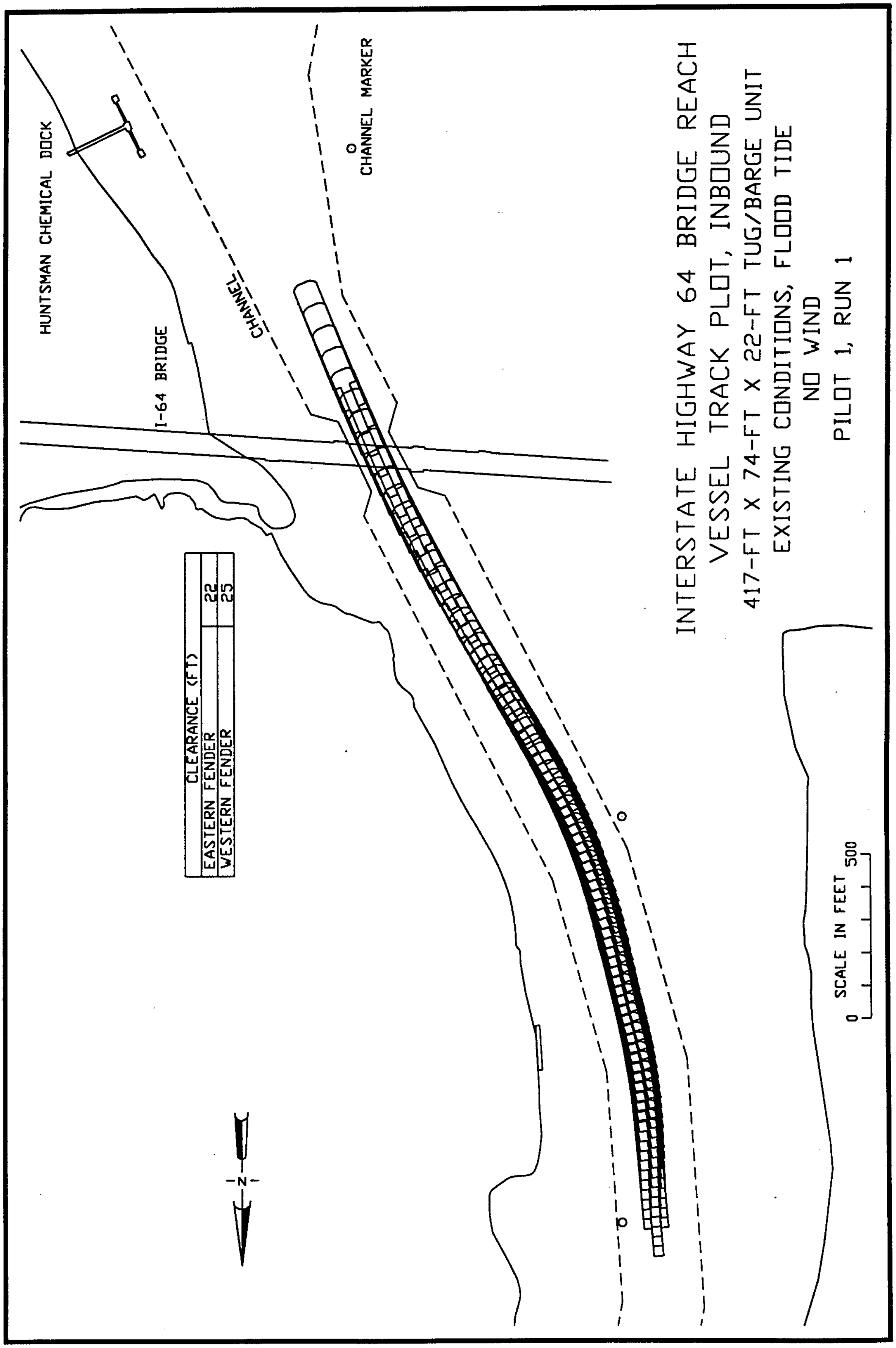
Plate 130

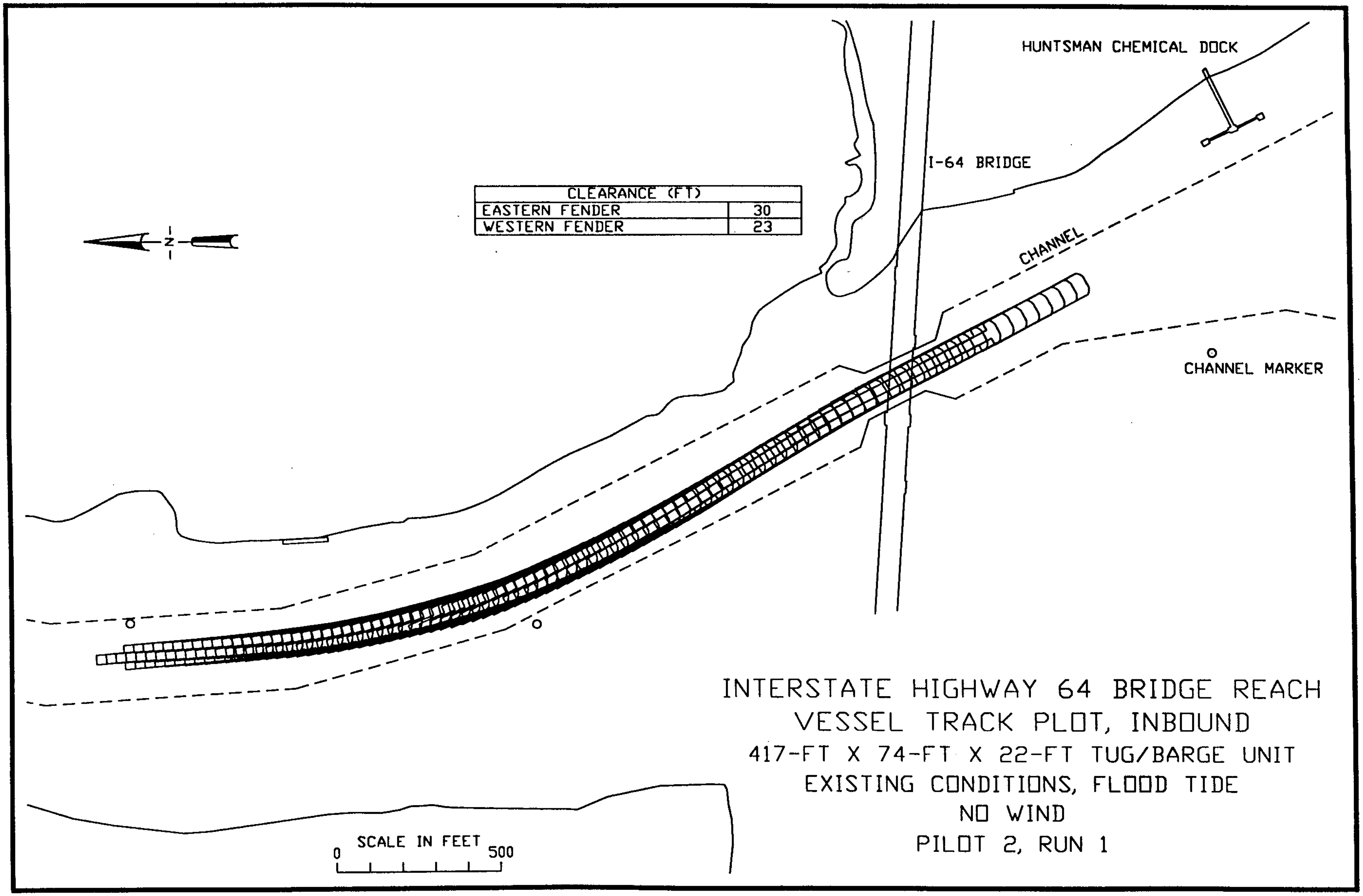

HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
N
CLEARANCE (FT)
EASTERN FENDER 28
WESTERN FENDER 28
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
NO WIND
PILOT 5, RUN 1



INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
NO WIND
PILOT 6, RUN 1

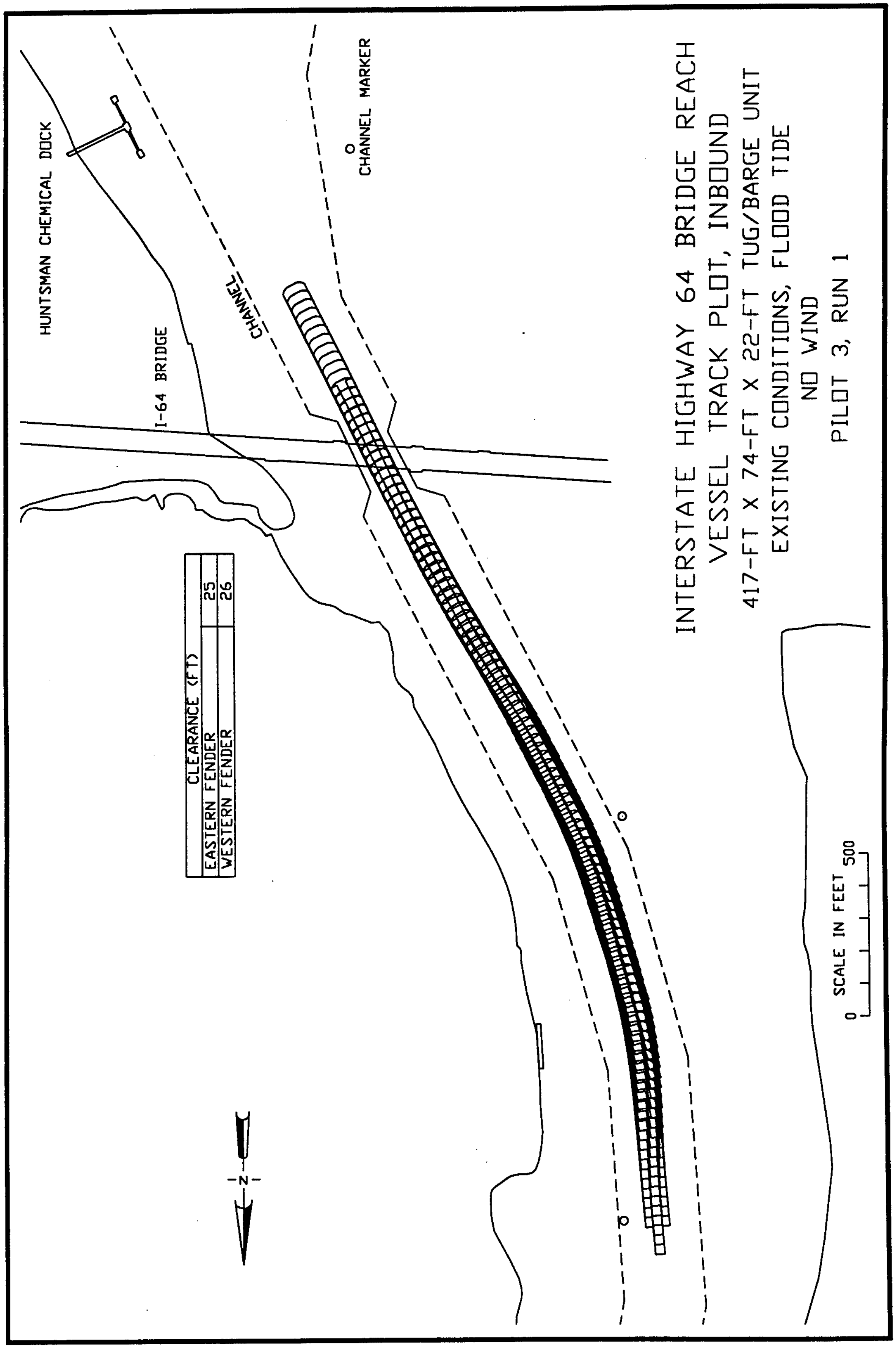
Plate 132


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
NO WIND
PILOT 1, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 22
WESTERN FENDER 25
N
SCALE IN FEET
0
500



CLEARANCE (FT)	
EASTERN FENDER	30
WESTERN FENDER	23

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
NO WIND
PILOT 2, RUN 1


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
NO WIND
PILOT 3, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
I-64 BRIDGE
CHANNEL
CLEARANCE (FT)
EASTERN FENDER 25
WESTERN FENDER 26
SCALE IN FEET
0
500
N

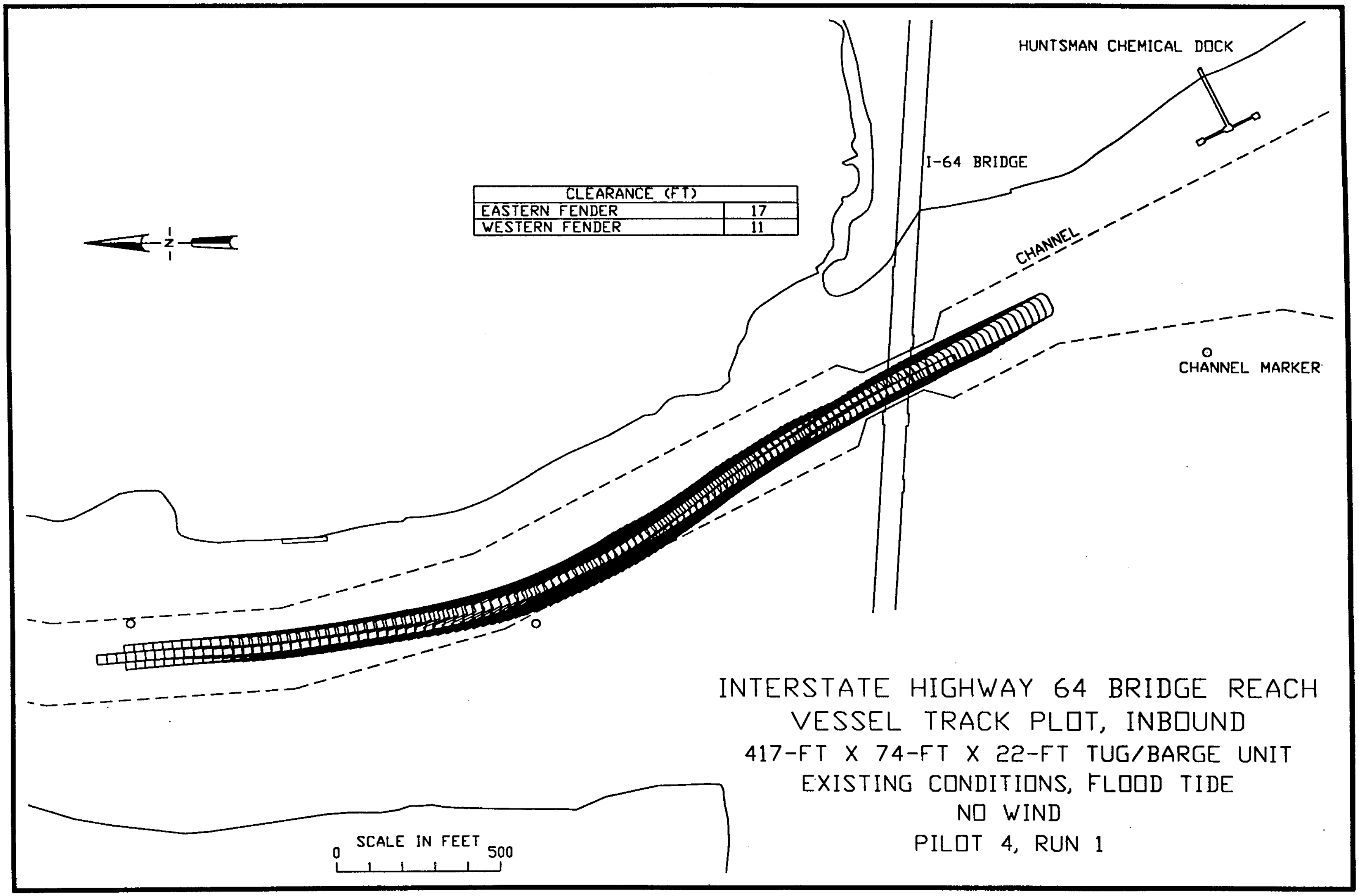
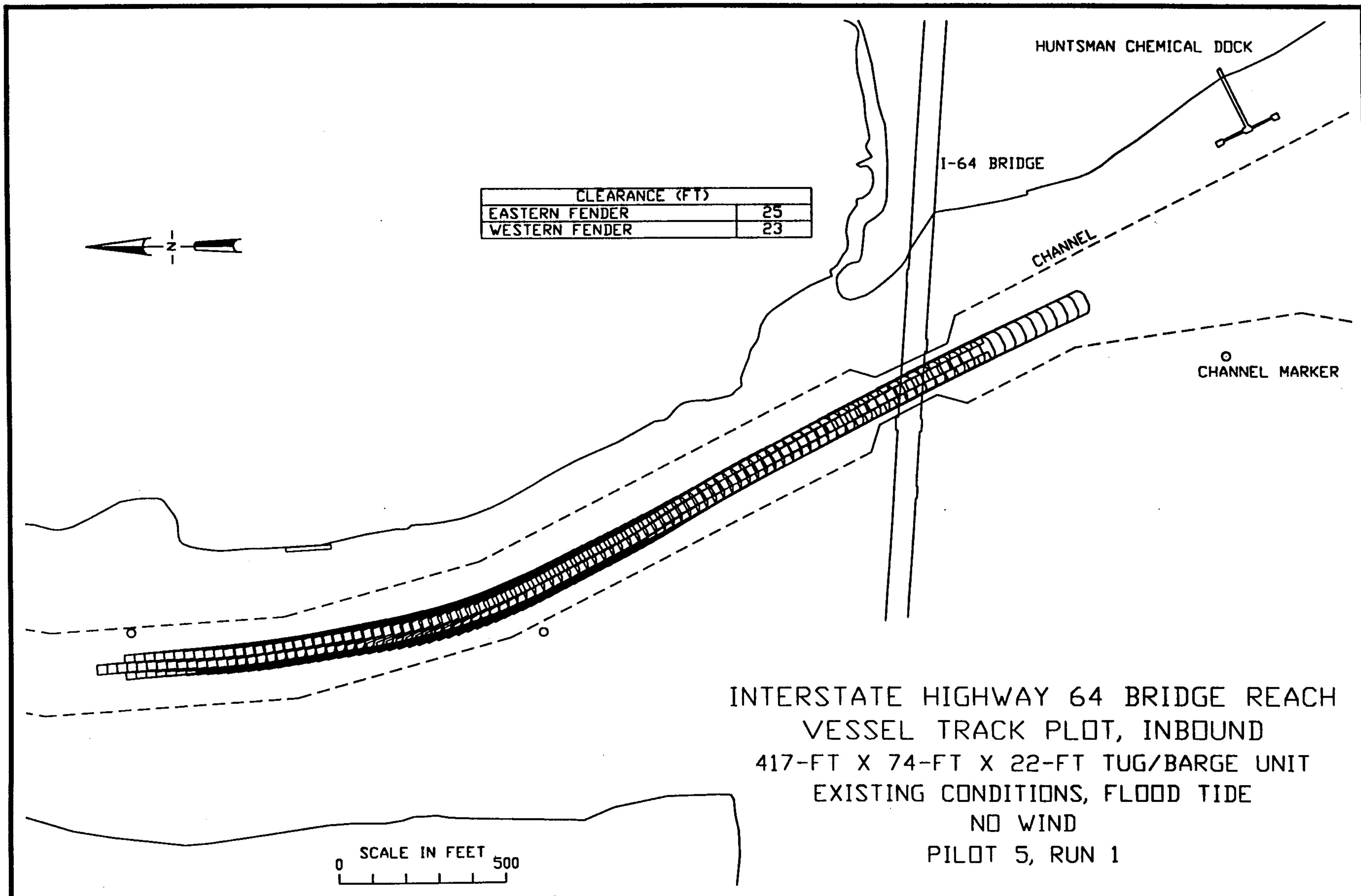

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
NO WIND
PILOT 4, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
N
SCALE IN FEET
0
500
CLEARANCE (FT)
EASTERN FENDER 17
WESTERN FENDER 11

Plate 136



CLEARANCE (FT)	
EASTERN FENDER	25
WESTERN FENDER	23

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
NO WIND
PILOT 5, RUN 1

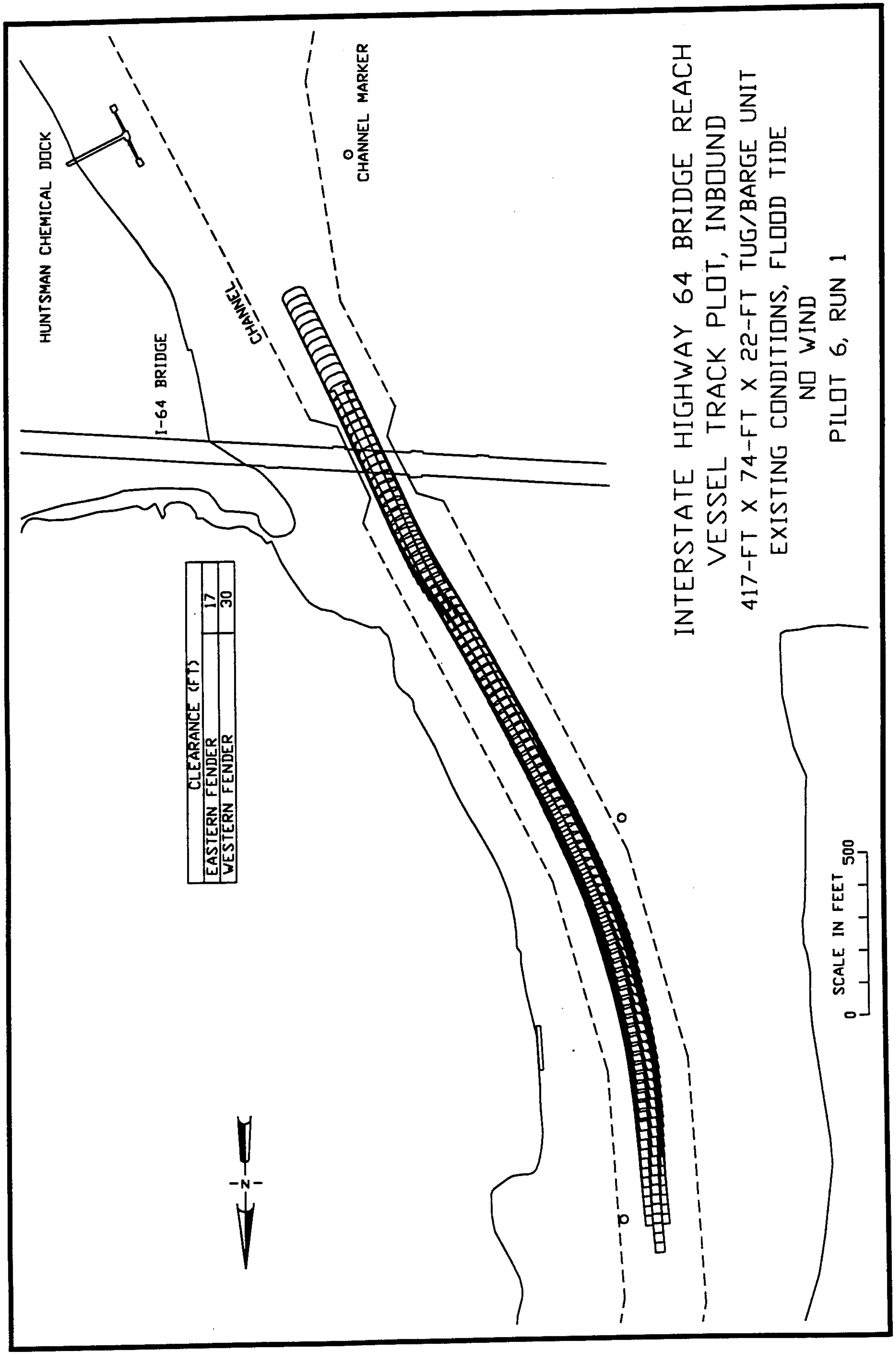
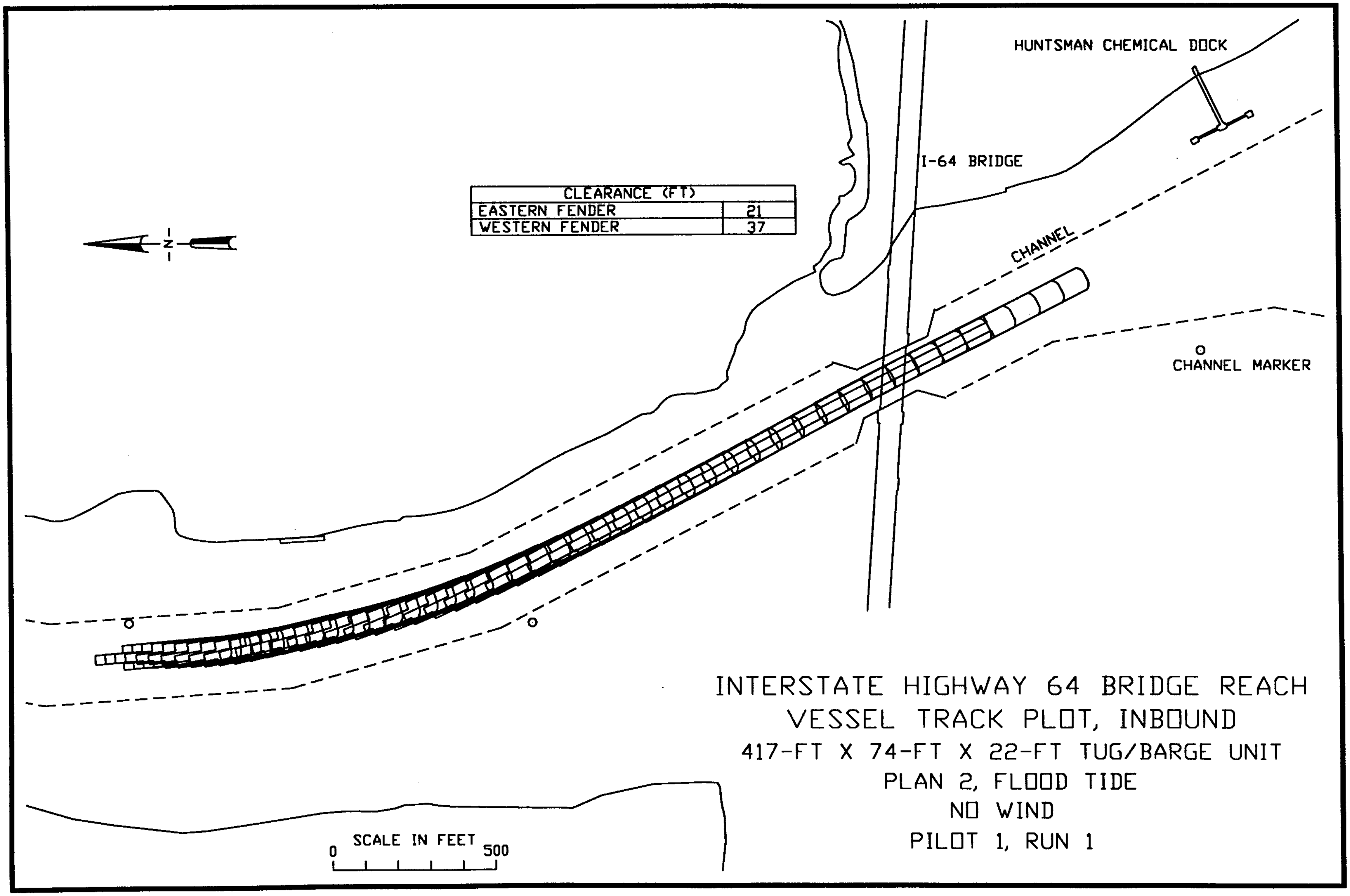
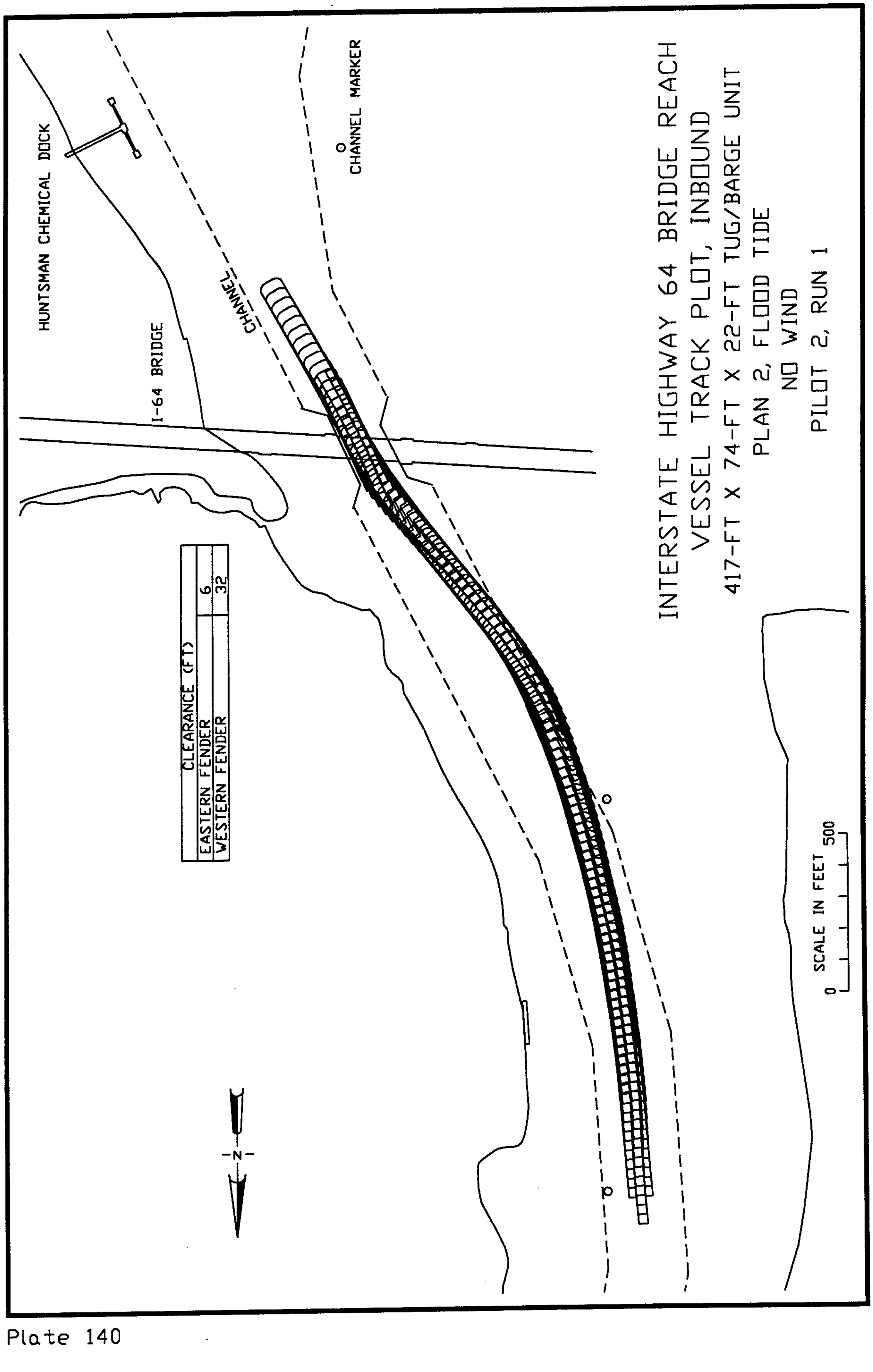
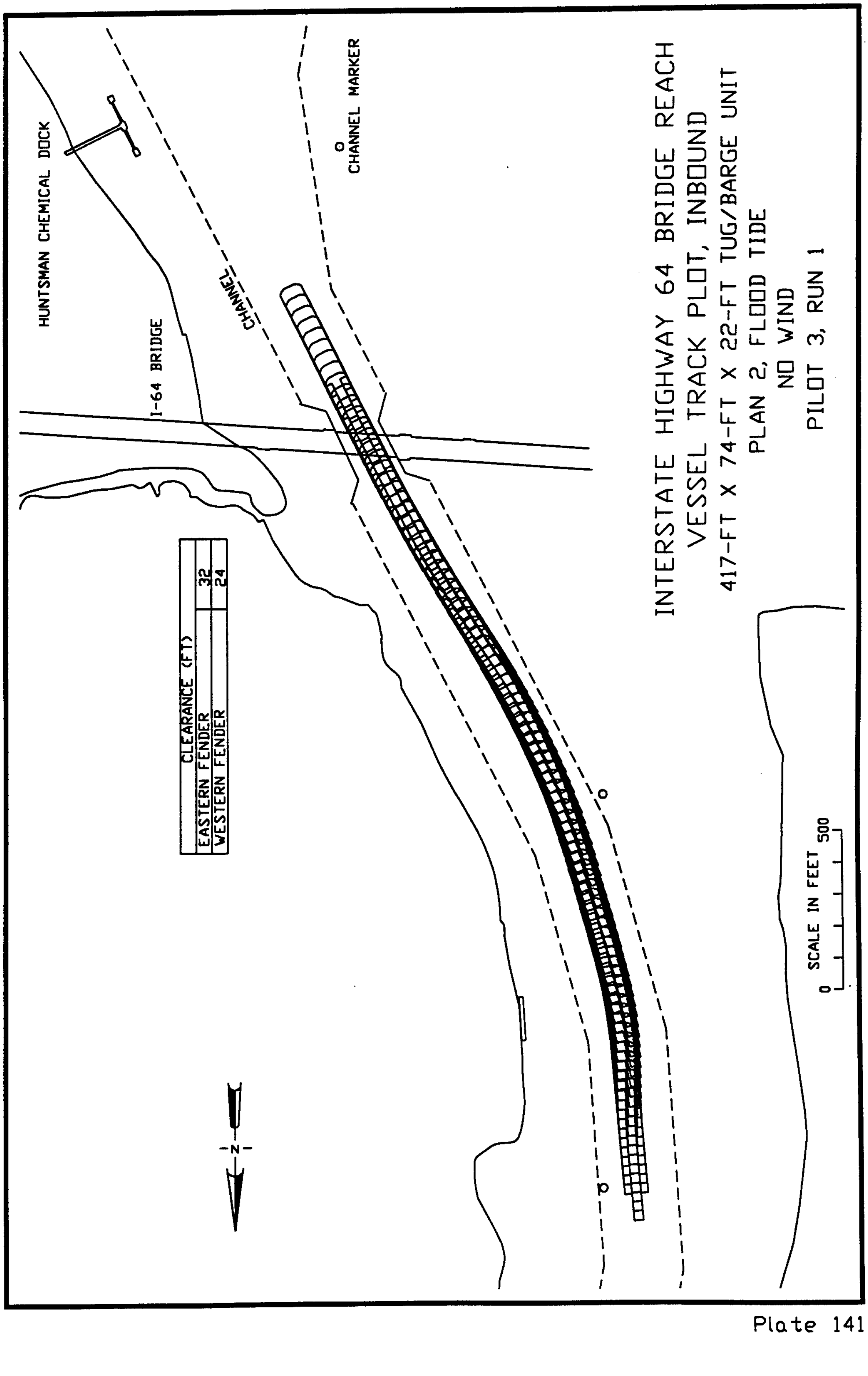

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
NO WIND
PILOT 6, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 17
WESTERN FENDER 30
SCALE IN FEET
0
500
N

Plate 138


HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 21
WESTERN FENDER 37
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
NO WIND
PILOT 1, RUN 1


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
NO WIND
PILOT 2, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 6
WESTERN FENDER 32
N
SCALE IN FEET
0
500



INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
NO WIND
PILOT 3, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 32
WESTERN FENDER 24
SCALE IN FEET
0
500
N

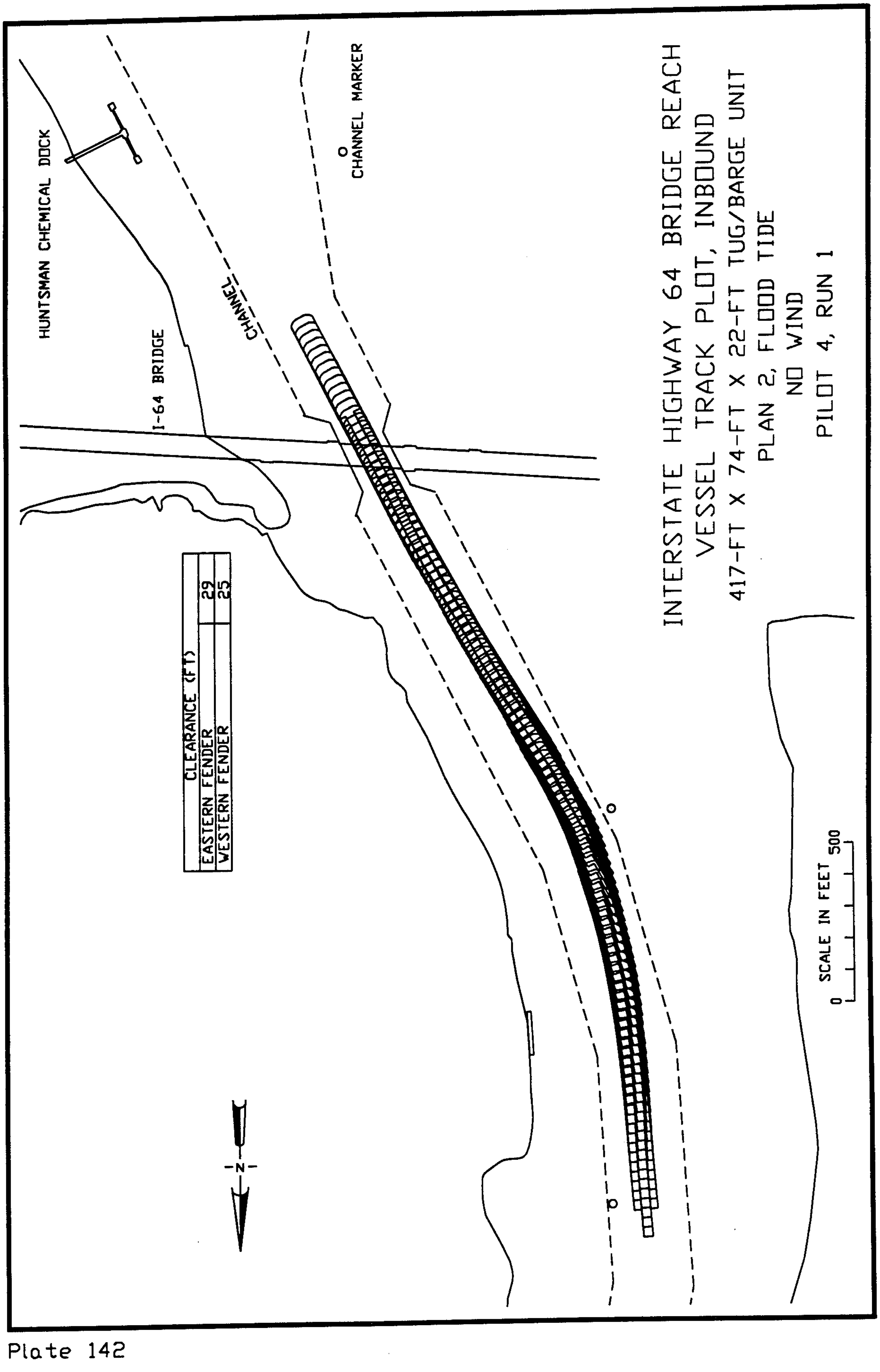
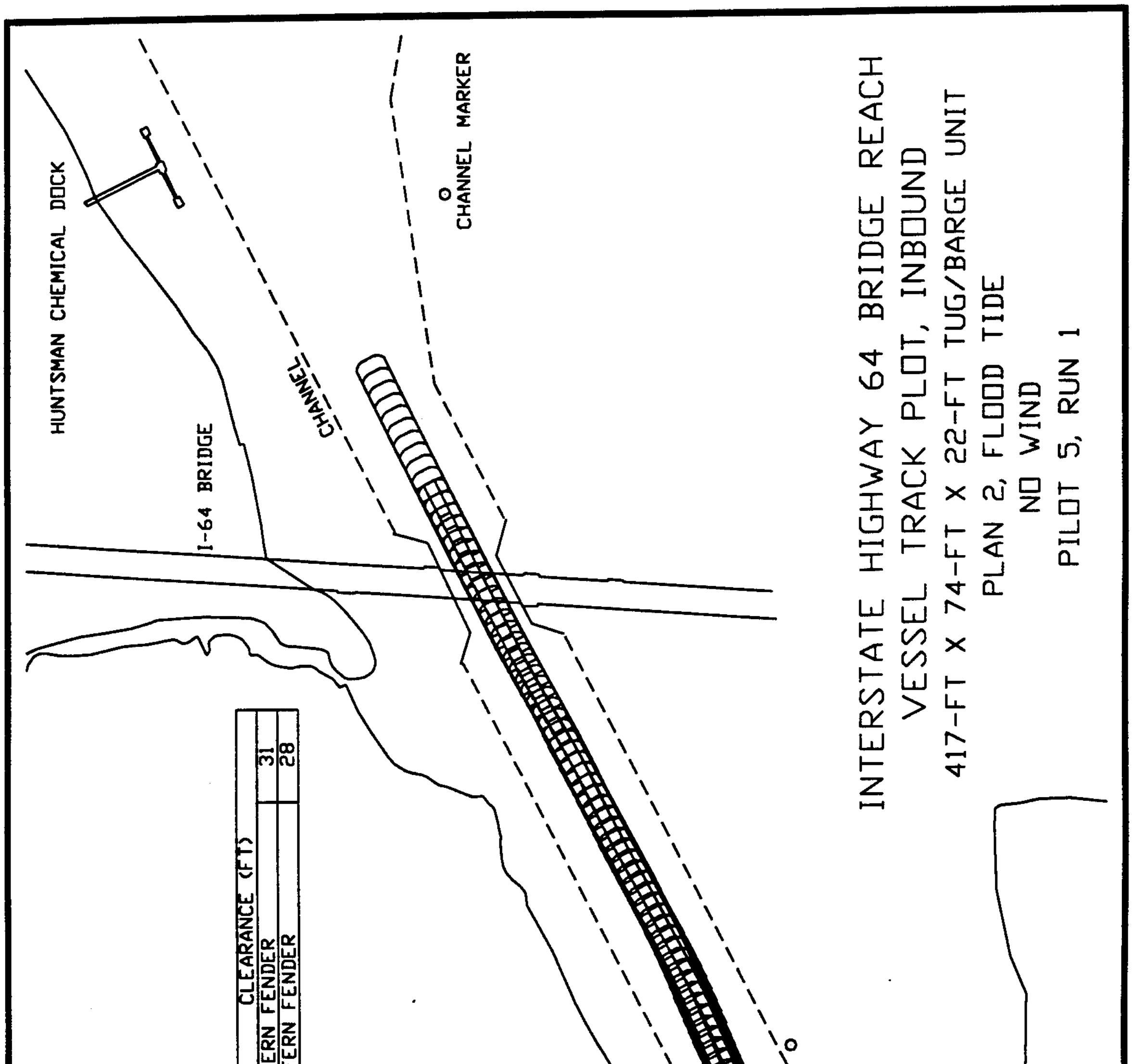
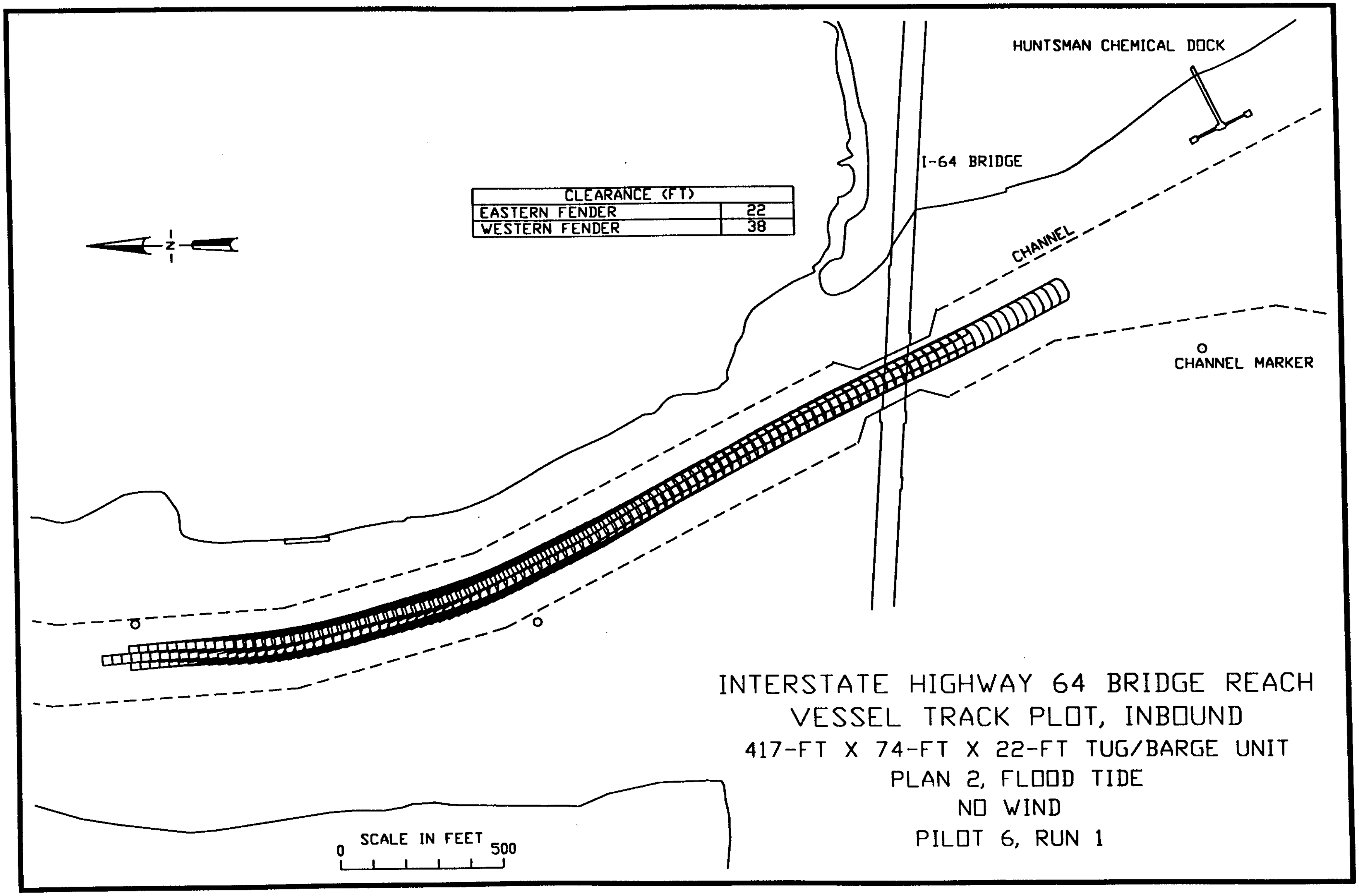
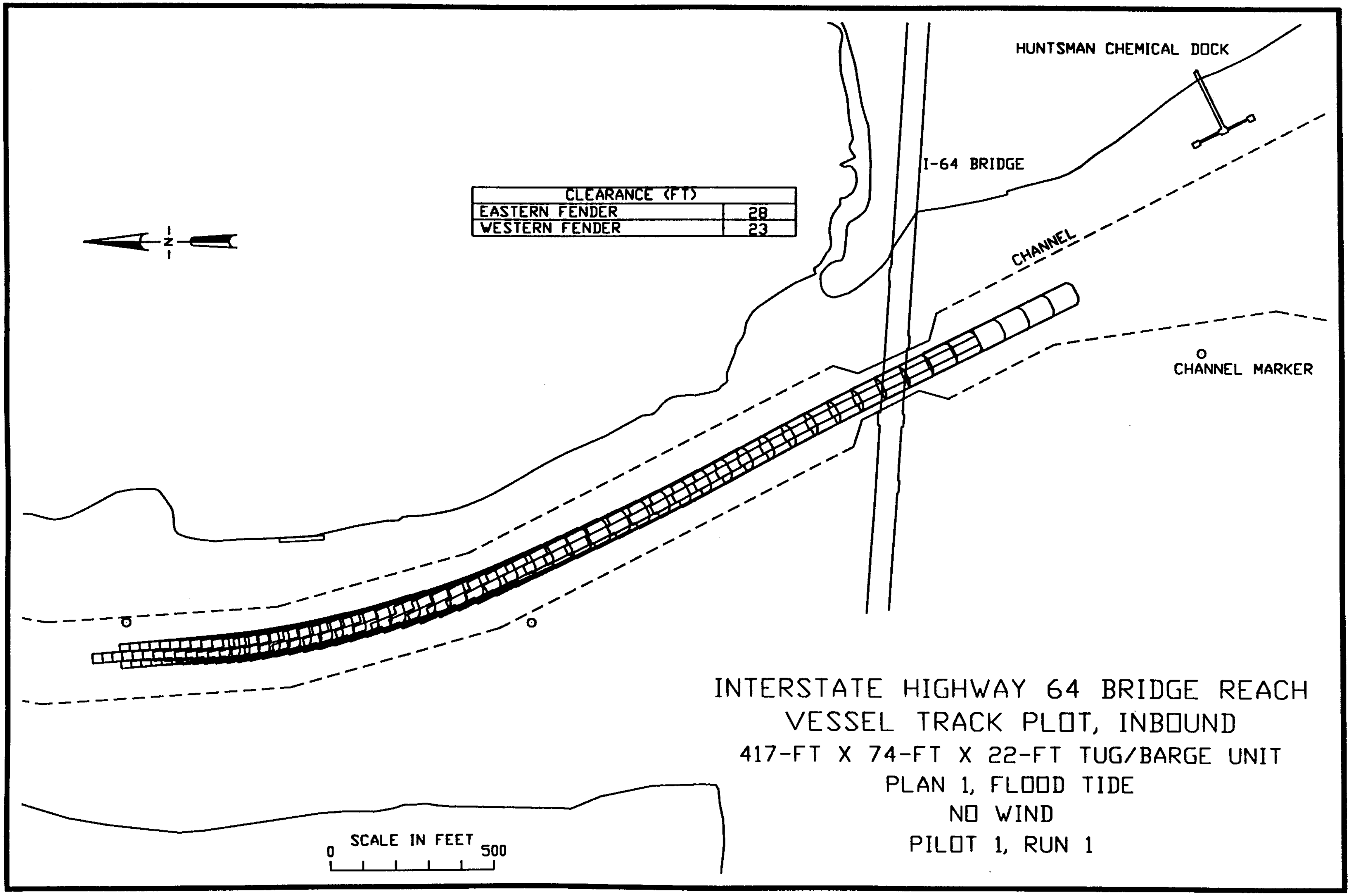

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
NO WIND
PILOT 4, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
CHANNEL
I-64 BRIDGE
CLEARANCE (FT)
EASTERN FENDER 29
WESTERN FENDER 25
N
SCALE IN FEET
0
500

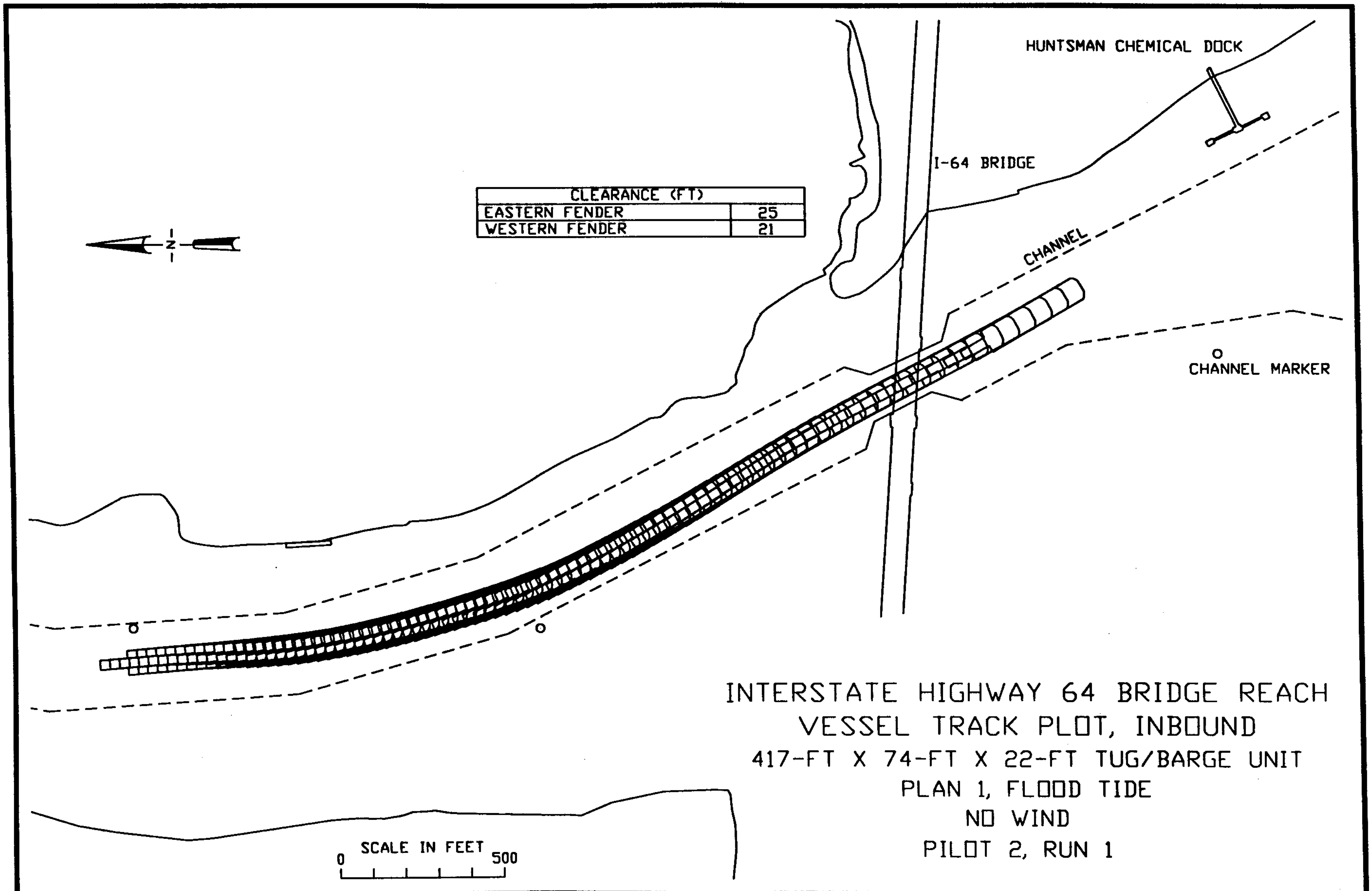
Plate 142


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
NO WIND
PILOT 5, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 31
WESTERN FENDER 28
SCALE IN FEET
0
500
N


HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 22
WESTERN FENDER 38
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
NO WIND
PILOT 6, RUN 1

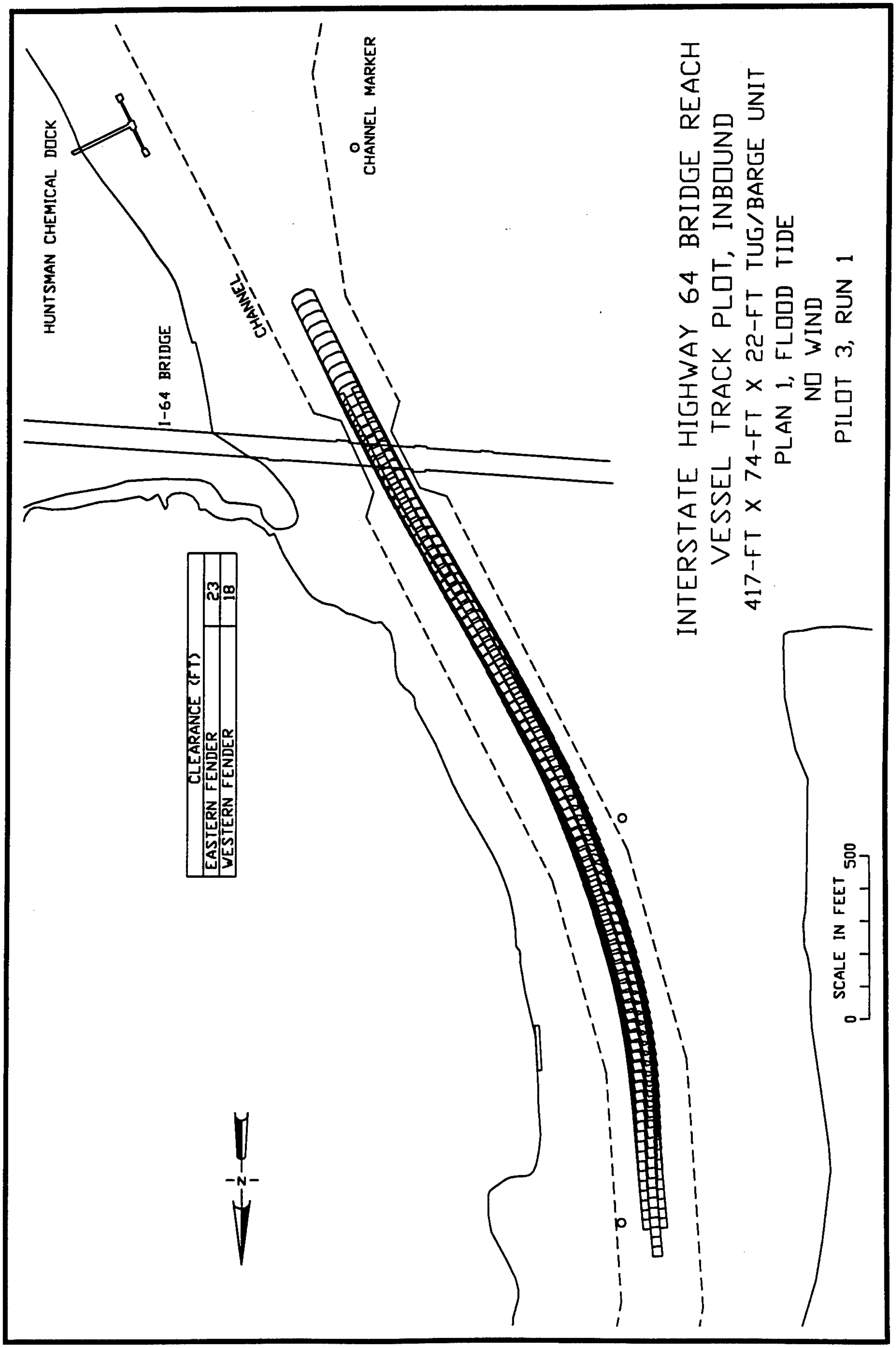


CLEARANCE (FT)	
EASTERN FENDER	28
WESTERN FENDER	23



CLEARANCE (FT)	
EASTERN FENDER	25
WESTERN FENDER	21

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
NO WIND
PILOT 2, RUN 1



INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
NO WIND
PILOT 3, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
I-64 BRIDGE
CHANNEL
CLEARANCE (FT)
EASTERN FENDER 23
WESTERN FENDER 18
N
SCALE IN FEET
0
500

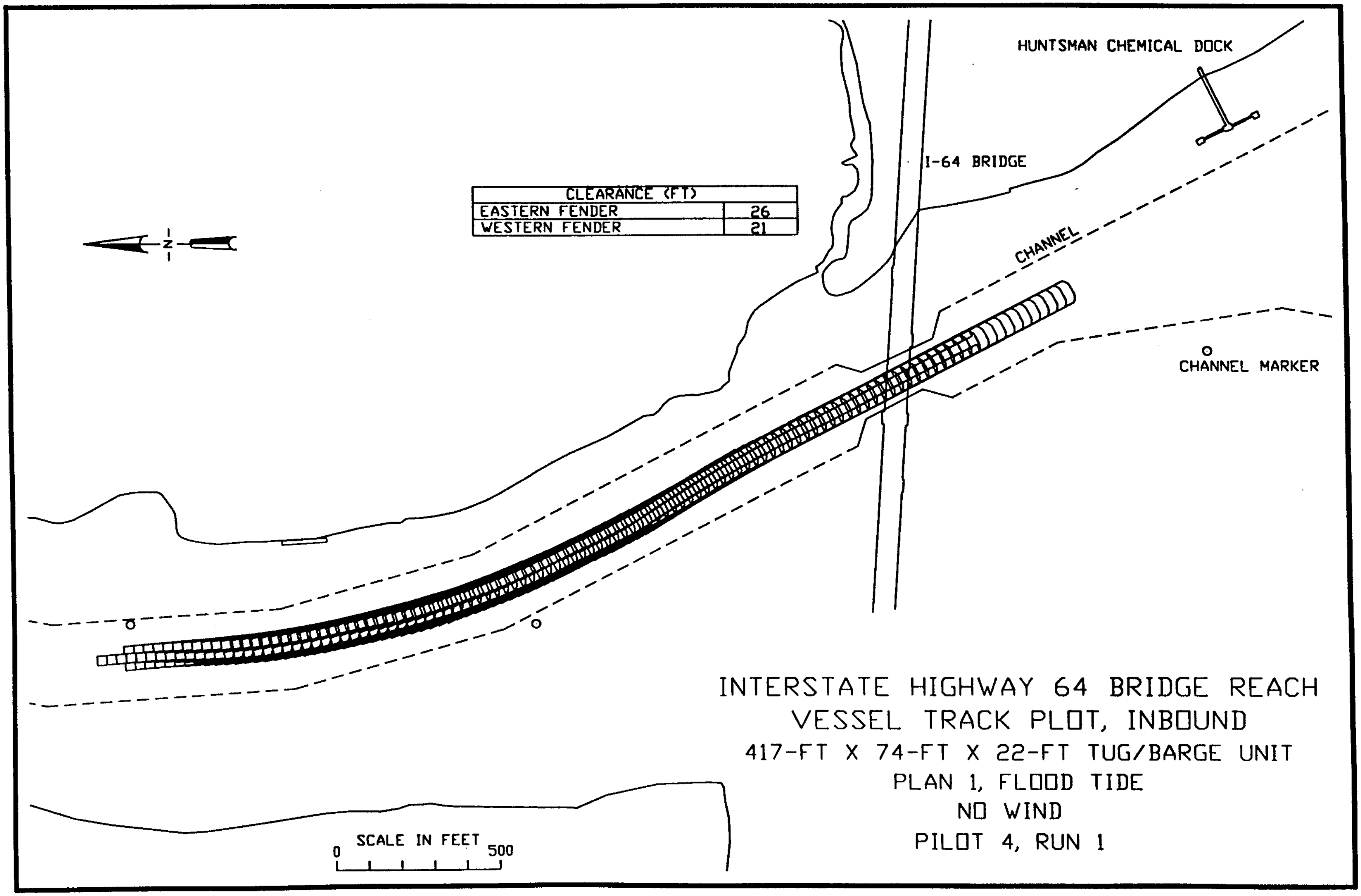
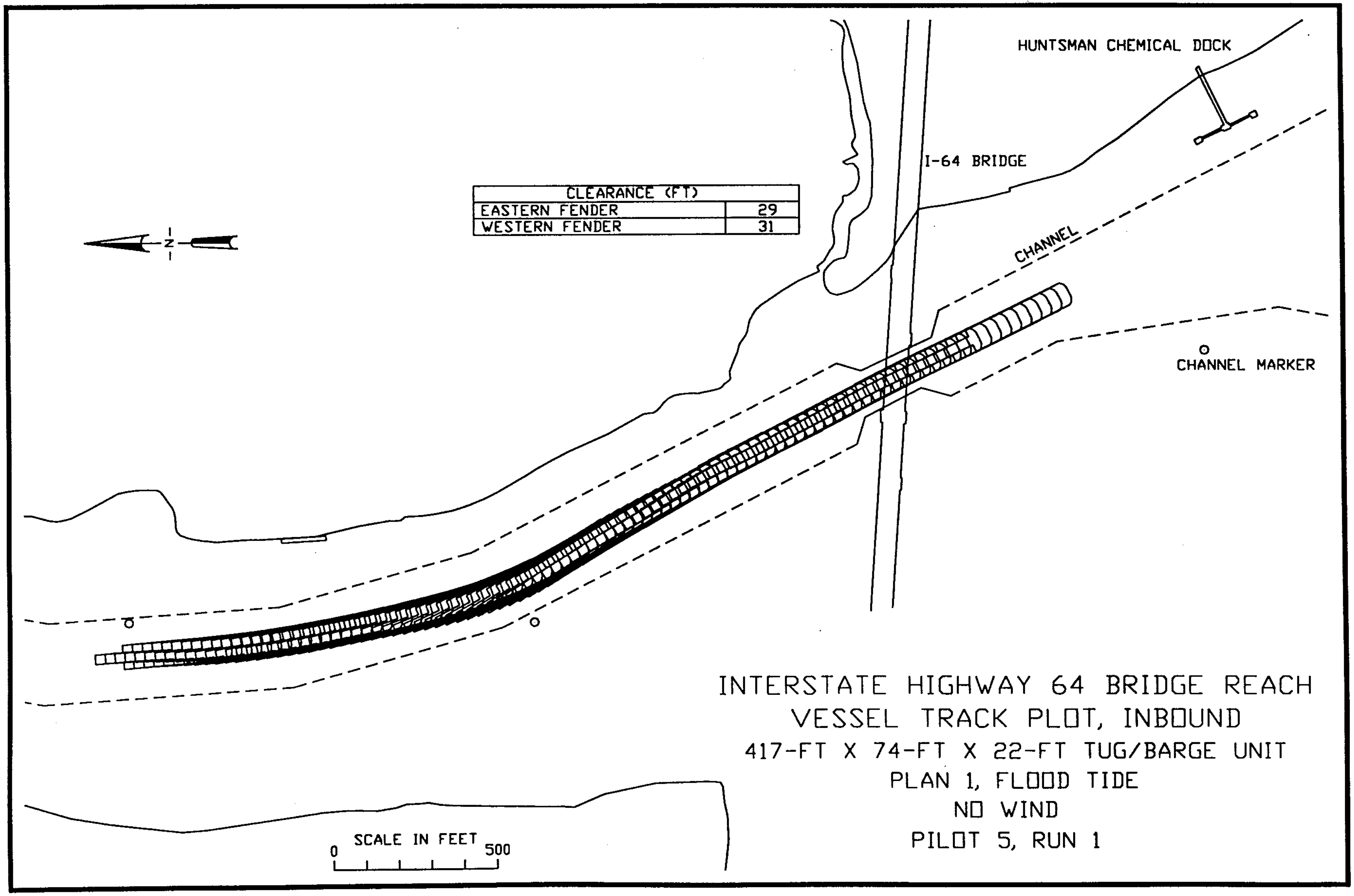

HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 26
WESTERN FENDER 21
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
NO WIND
PILOT 4, RUN 1

Plate 148



CLEARANCE (FT)	
EASTERN FENDER	29
WESTERN FENDER	31

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
NO WIND
PILOT 5, RUN 1

Plate 149

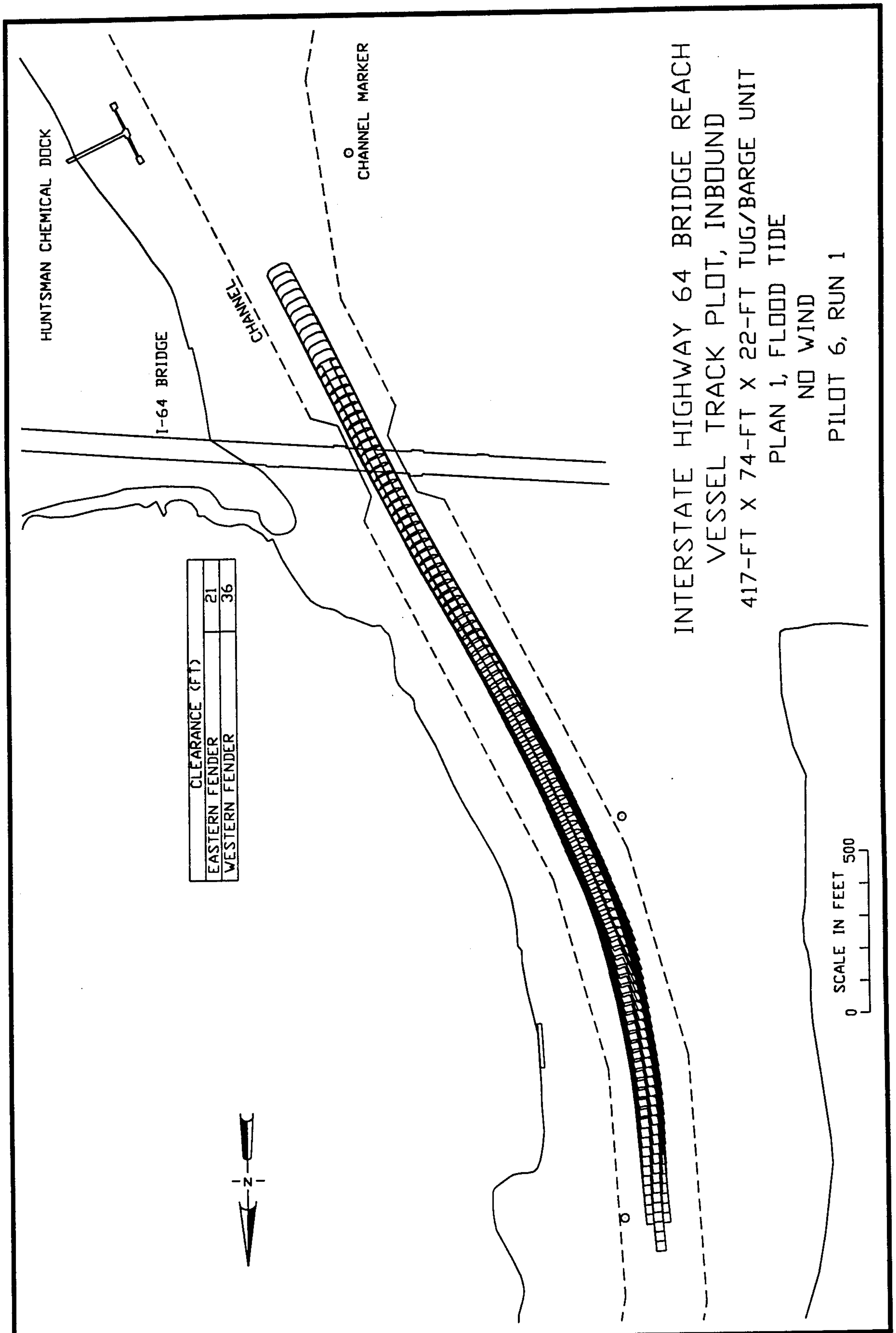
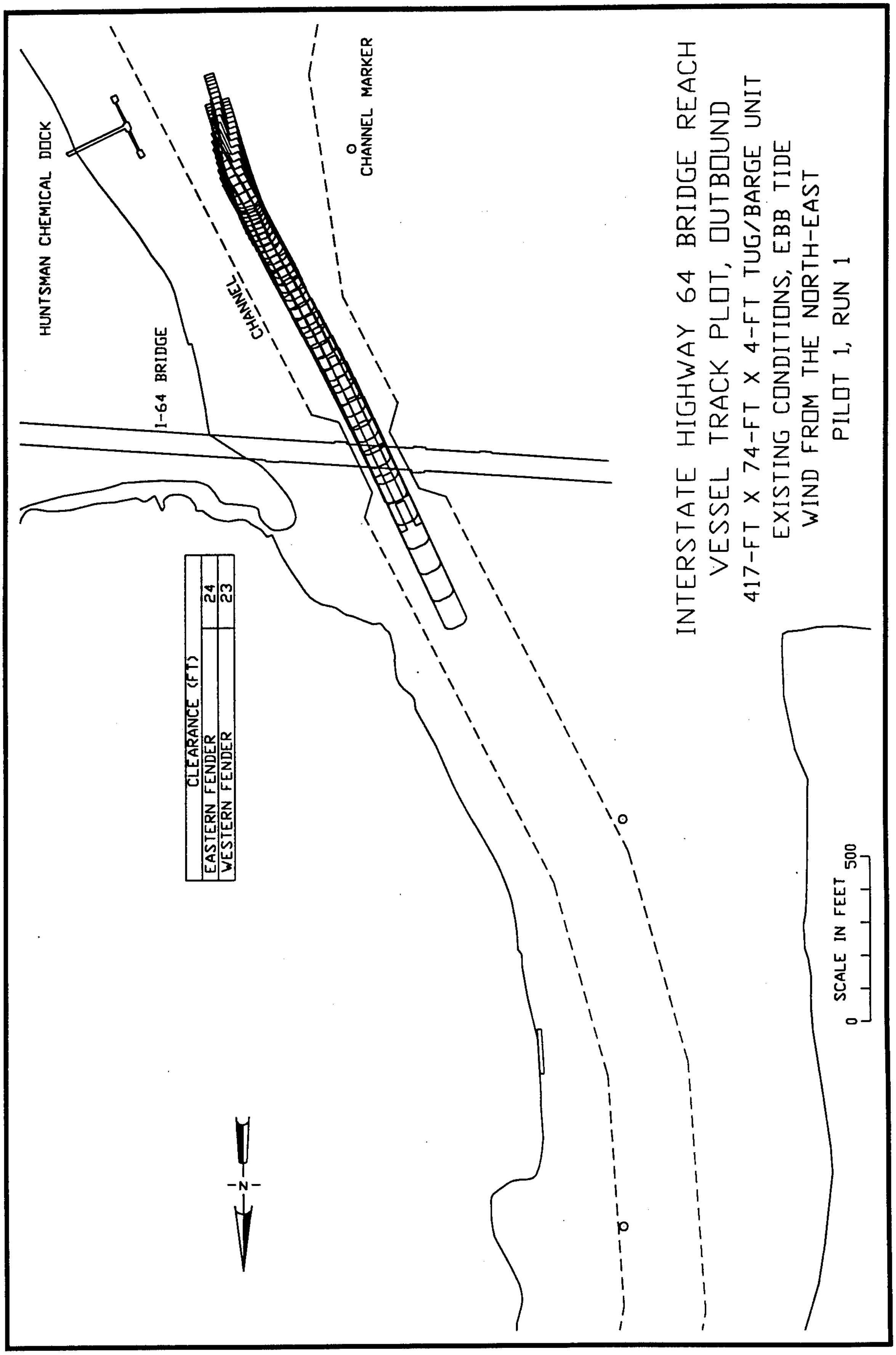
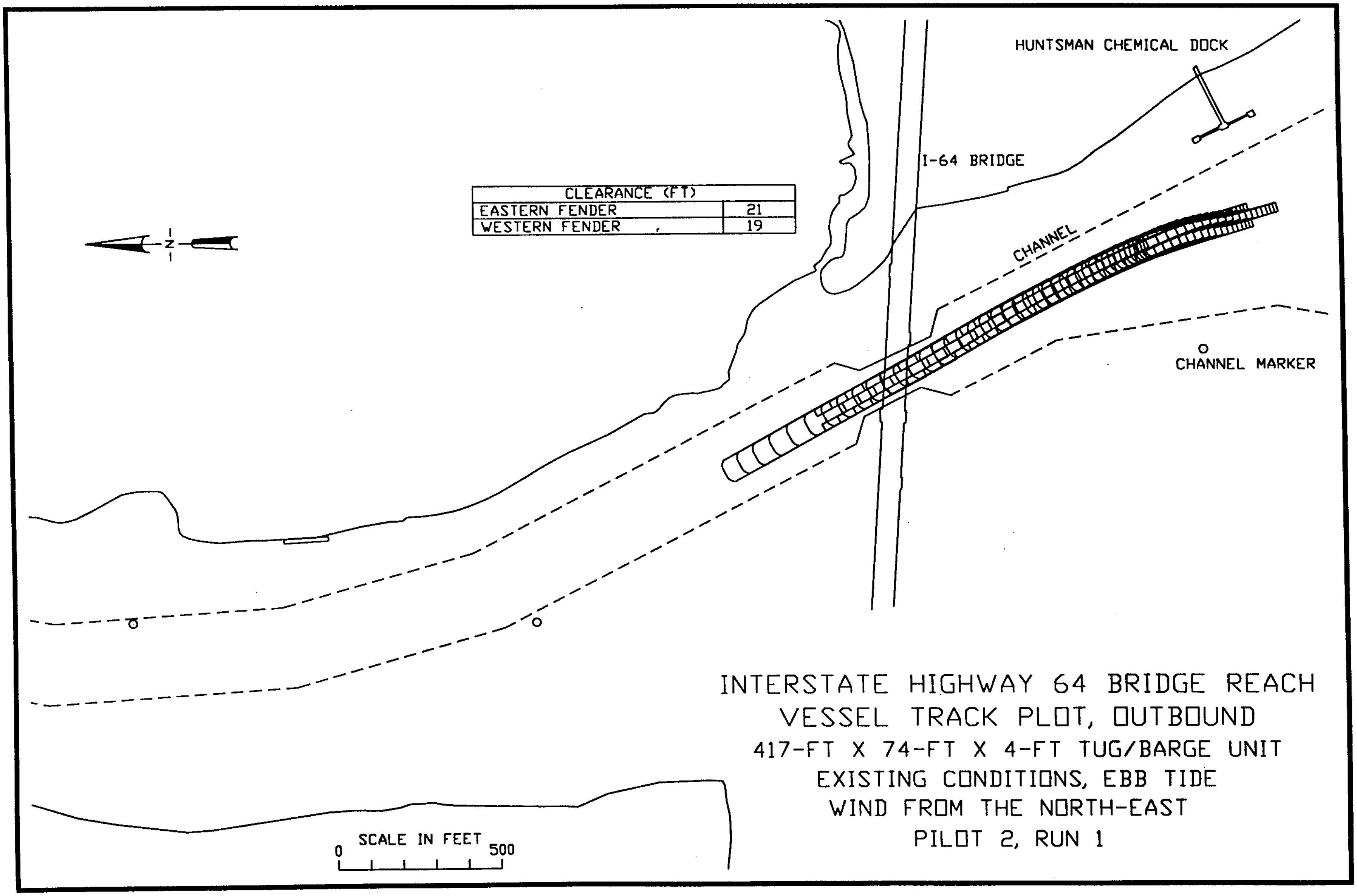

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
NO WIND
PILOT 6, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
CHANNEL
I-64 BRIDGE
CLEARANCE (FT)
EASTERN FENDER 21
WESTERN FENDER 36
SCALE IN FEET
0
500
N

Plate 150

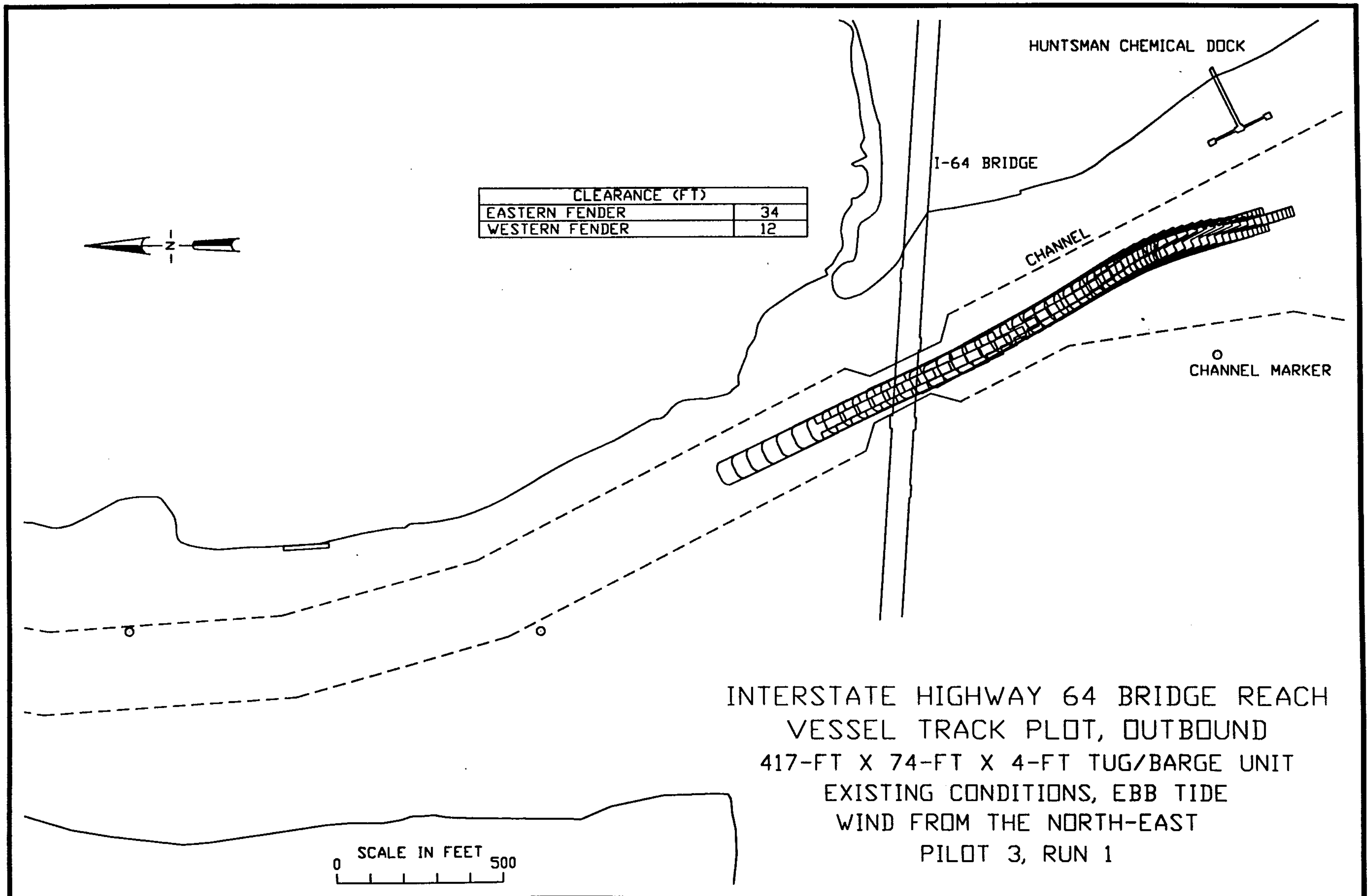

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 24
WESTERN FENDER 23
SCALE IN FEET
0
500
N



CLEARANCE (FT)	
EASTERN FENDER	21
WESTERN FENDER	19

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1

Plate 152



CLEARANCE (FT)	
EASTERN FENDER	34
WESTERN FENDER	12

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1

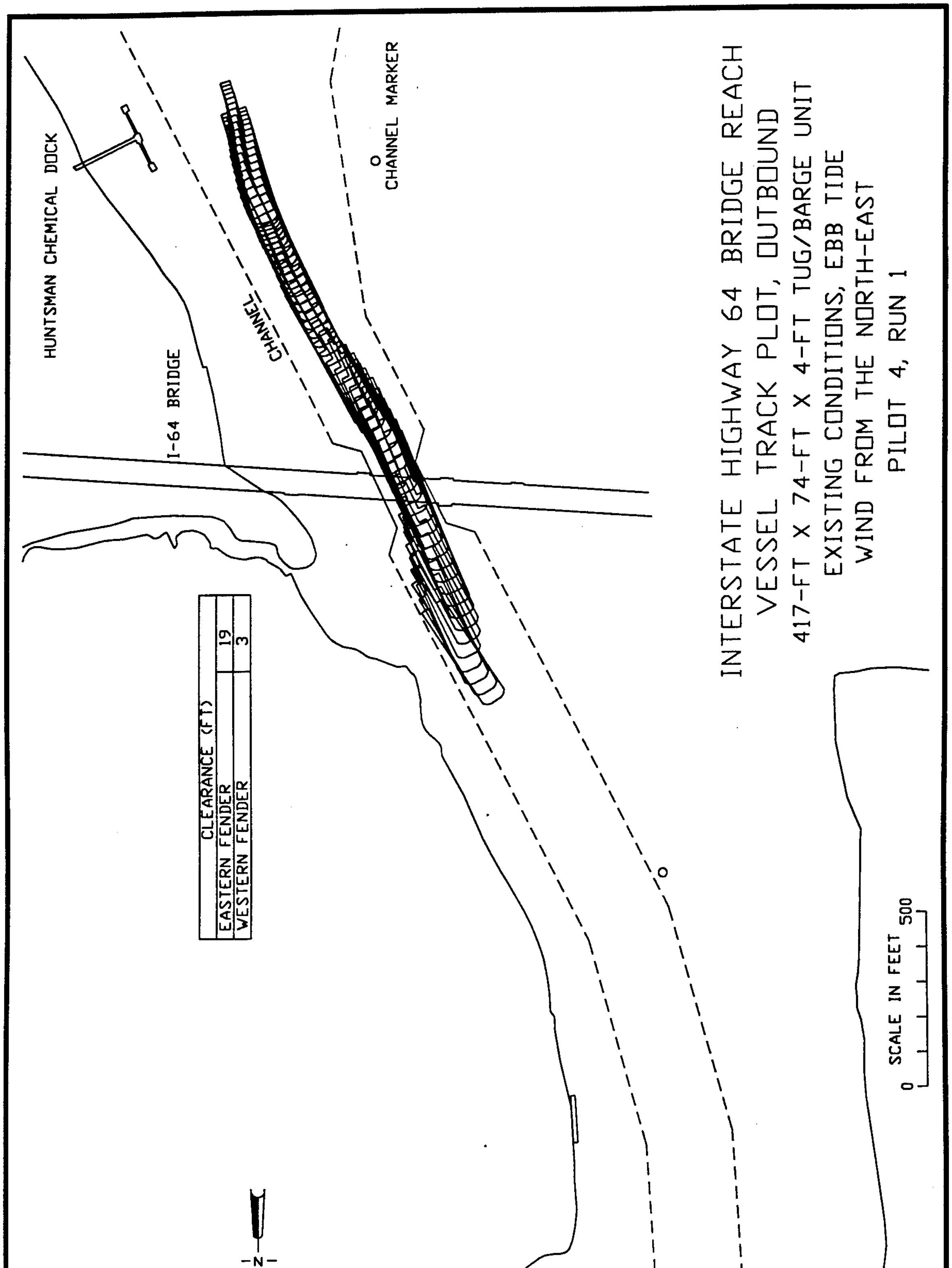
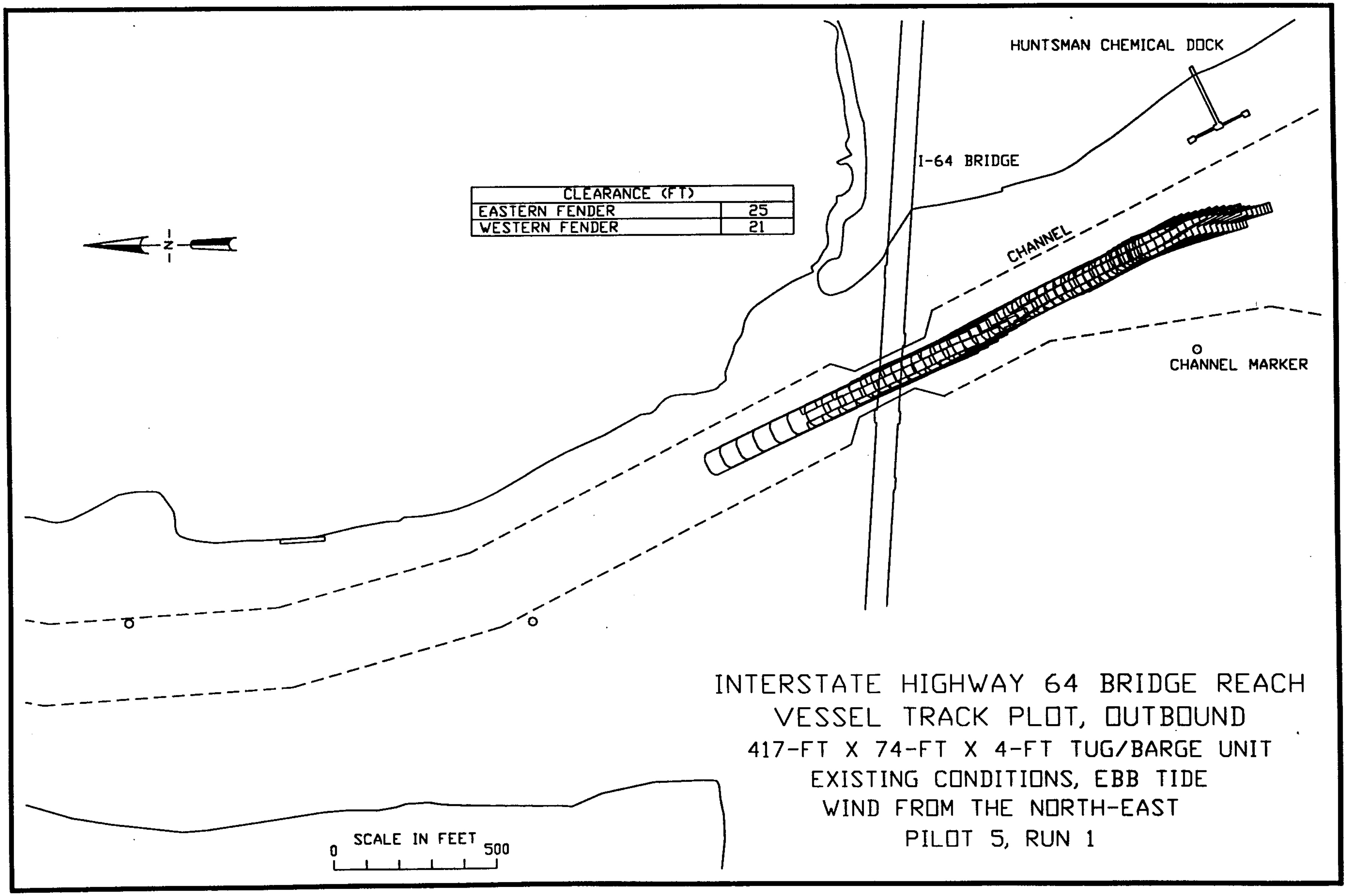
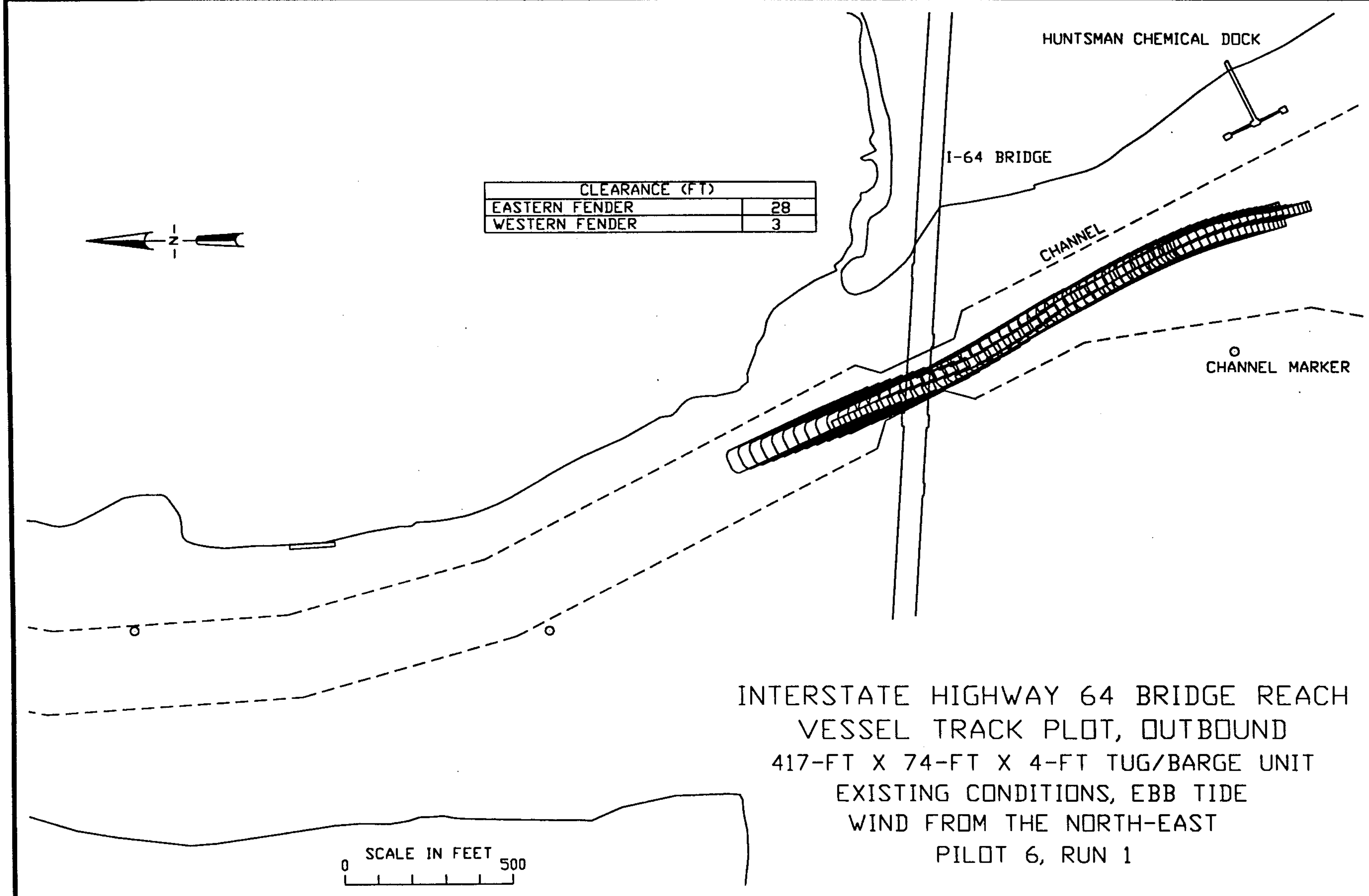

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
CHANNEL
I-64 BRIDGE
CLEARANCE (FT)
EASTERN FENDER 19
WESTERN FENDER 3
N
SCALE IN FEET
0
500

Plate 154



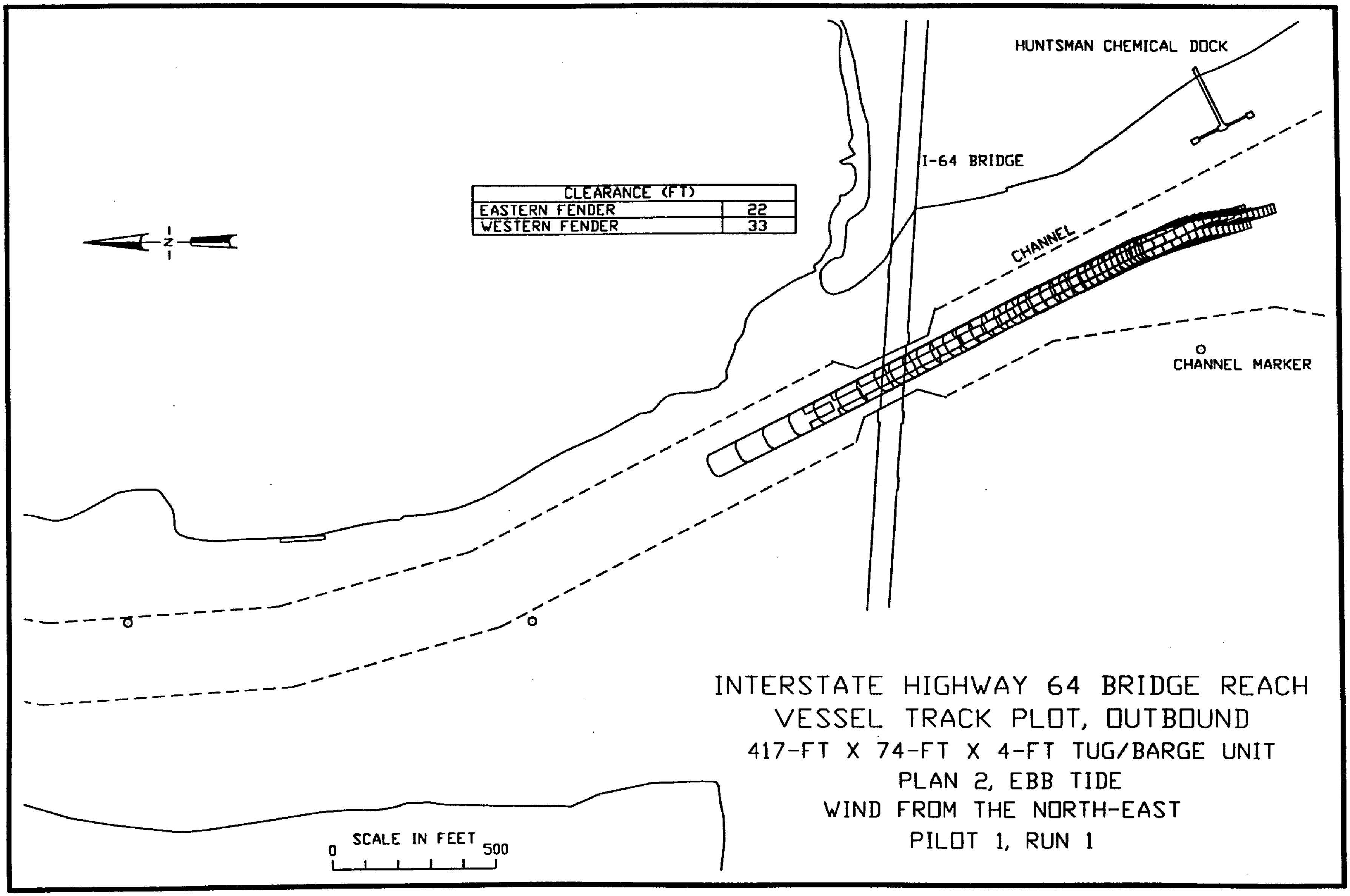
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1



CLEARANCE (FT)	
EASTERN FENDER	28
WESTERN FENDER	3

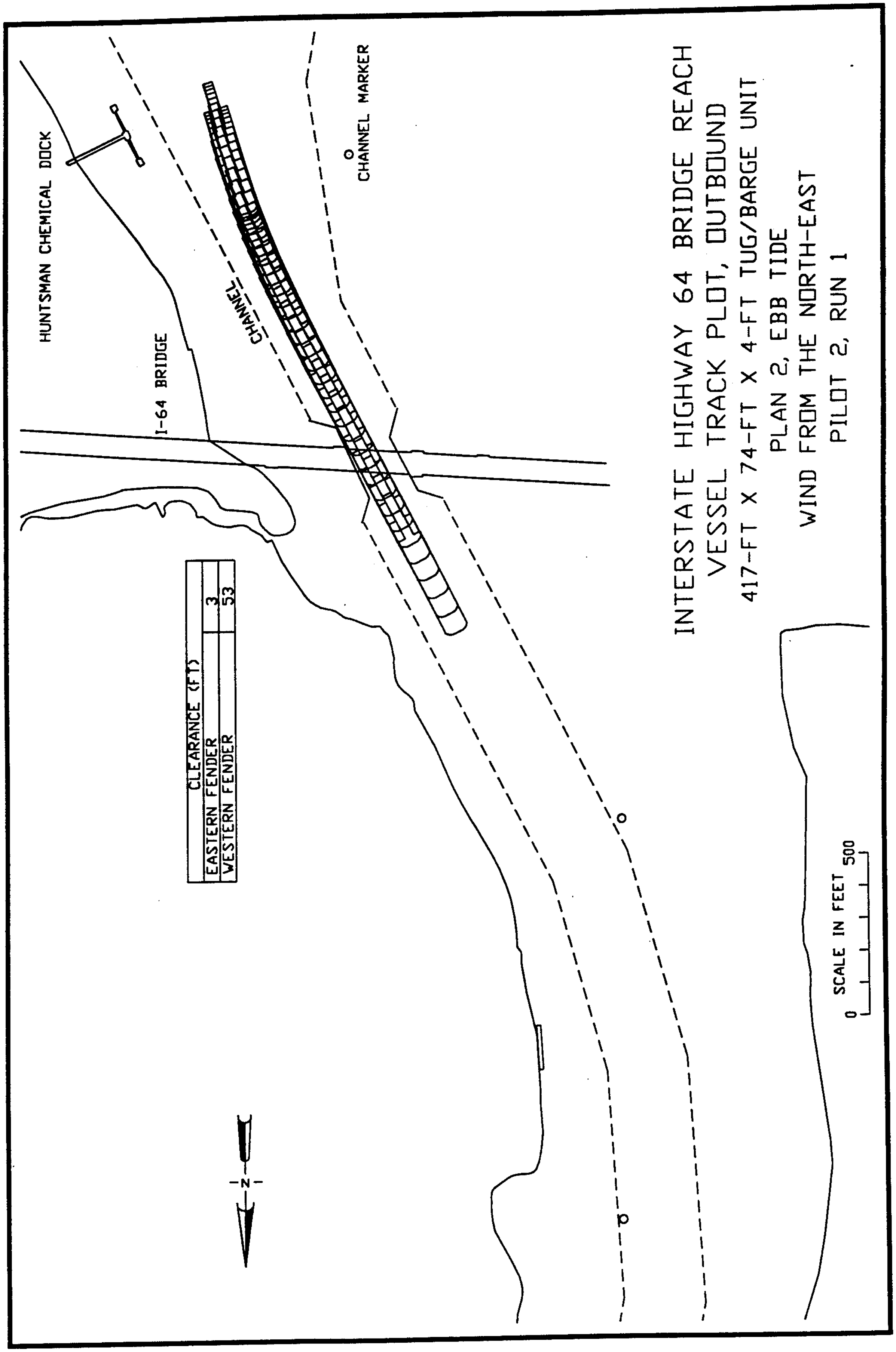
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1

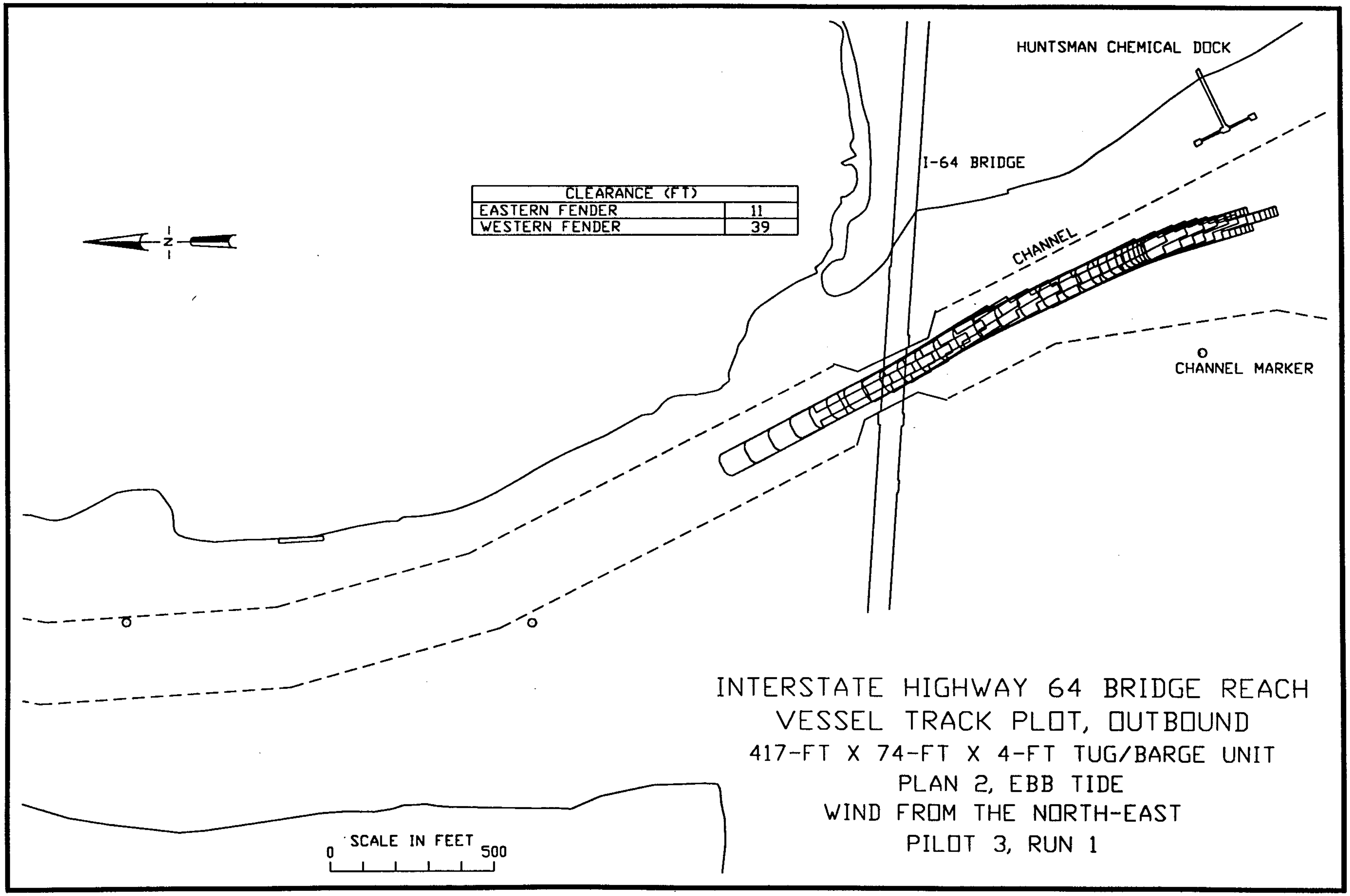
Plate 156



CLEARANCE (FT)	
EASTERN FENDER	22
WESTERN FENDER	33

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
I-64 BRIDGE
CHANNEL
CLEARANCE (FT)
EASTERN FENDER 3
WESTERN FENDER 53
N
SCALE IN FEET
0
500



CLEARANCE (FT)	
EASTERN FENDER	11
WESTERN FENDER	39

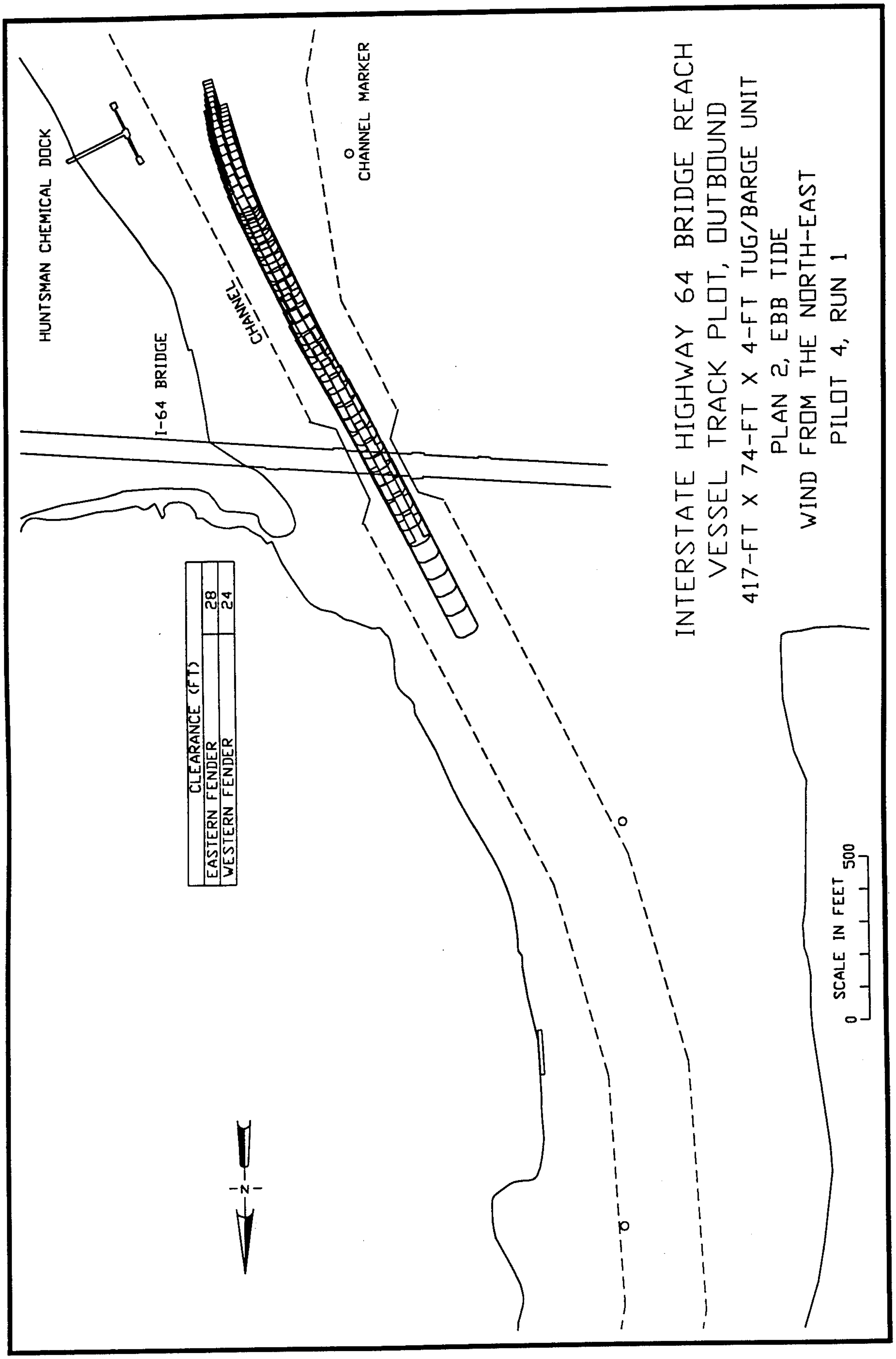
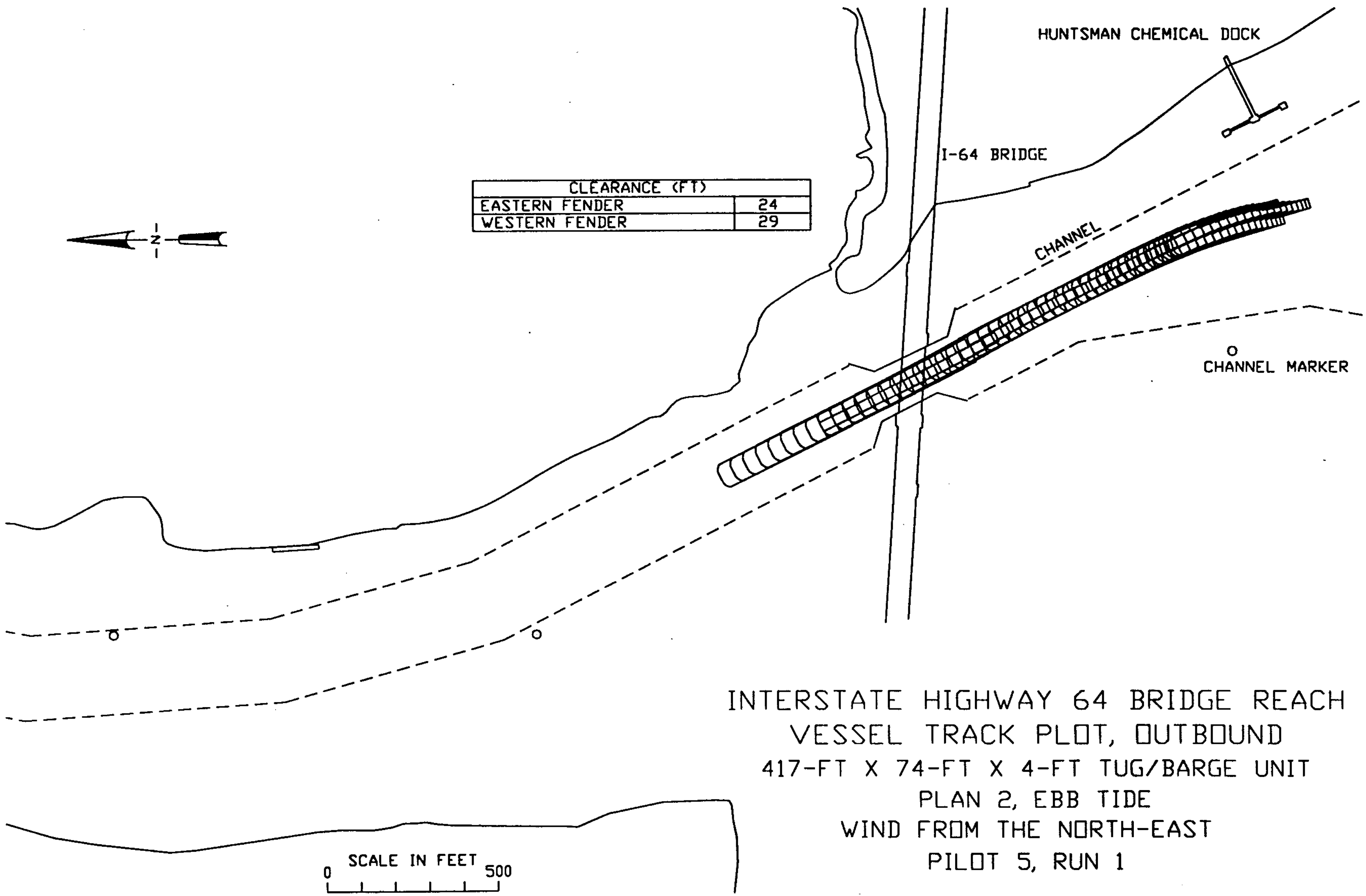

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
CHANNEL
I-64 BRIDGE
CLEARANCE (FT)
EASTERN FENDER 28
WESTERN FENDER 24
SCALE IN FEET
0
500
N

Plate 160



CLEARANCE (FT)	
EASTERN FENDER	24
WESTERN FENDER	29

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1

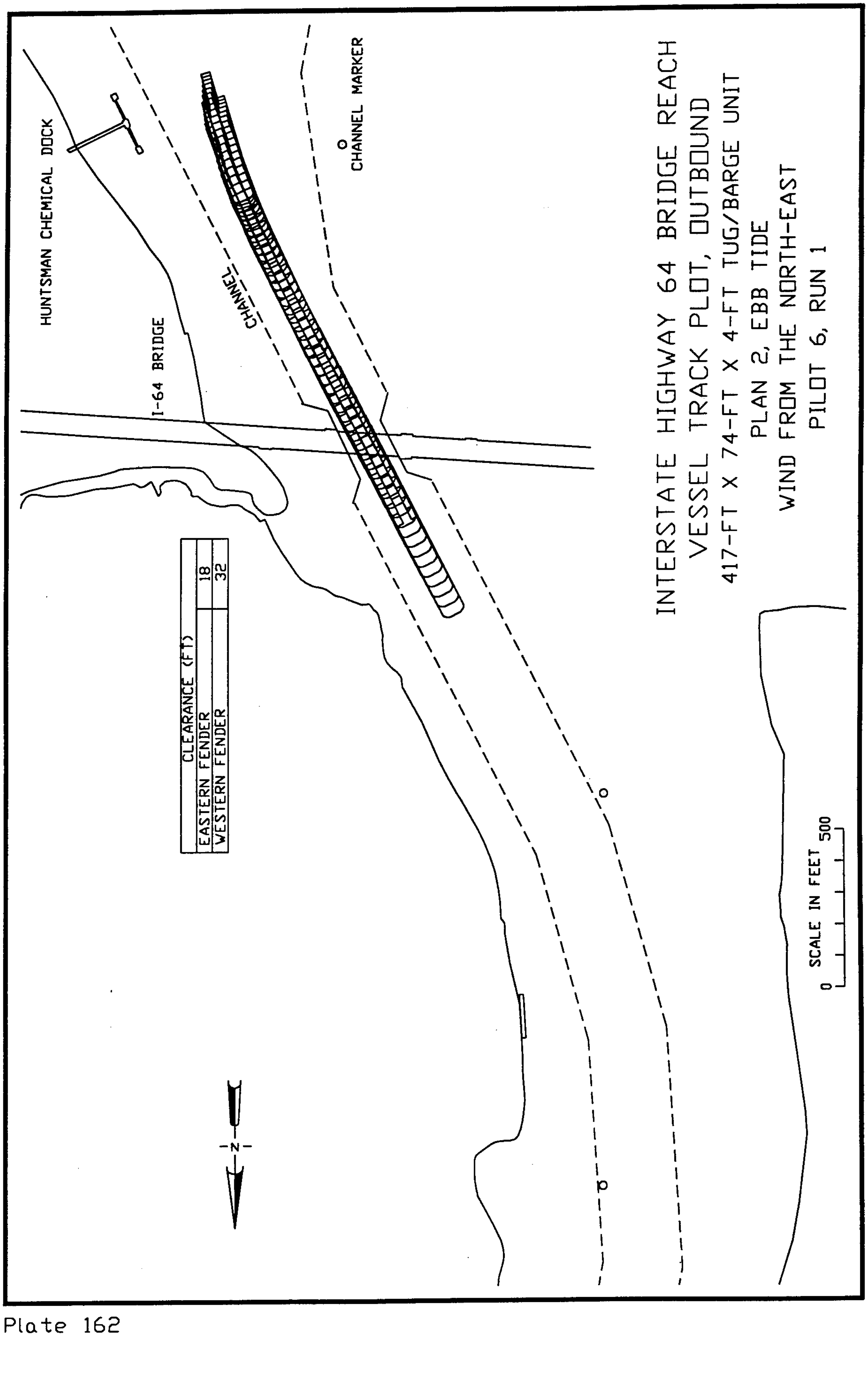
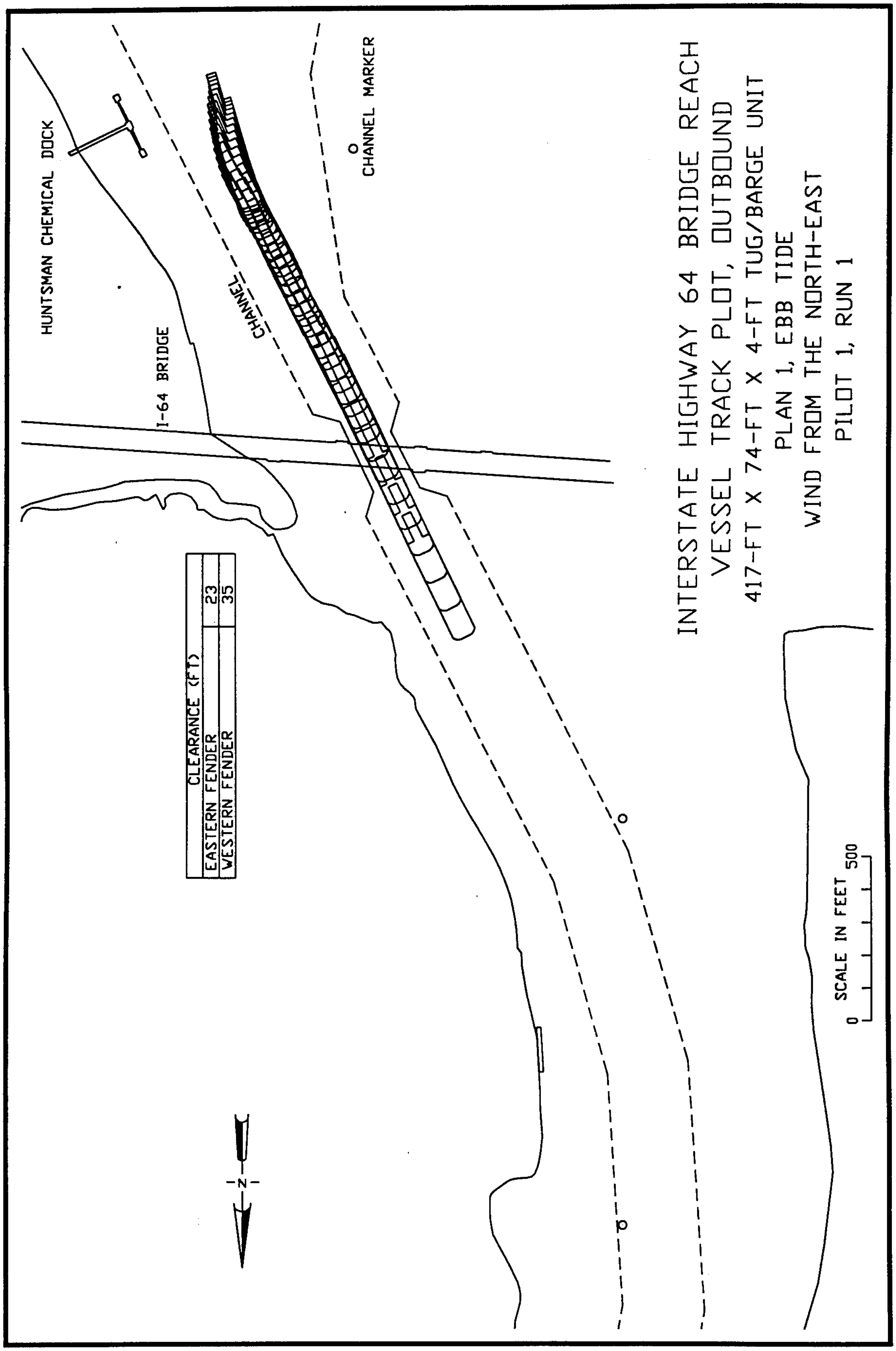
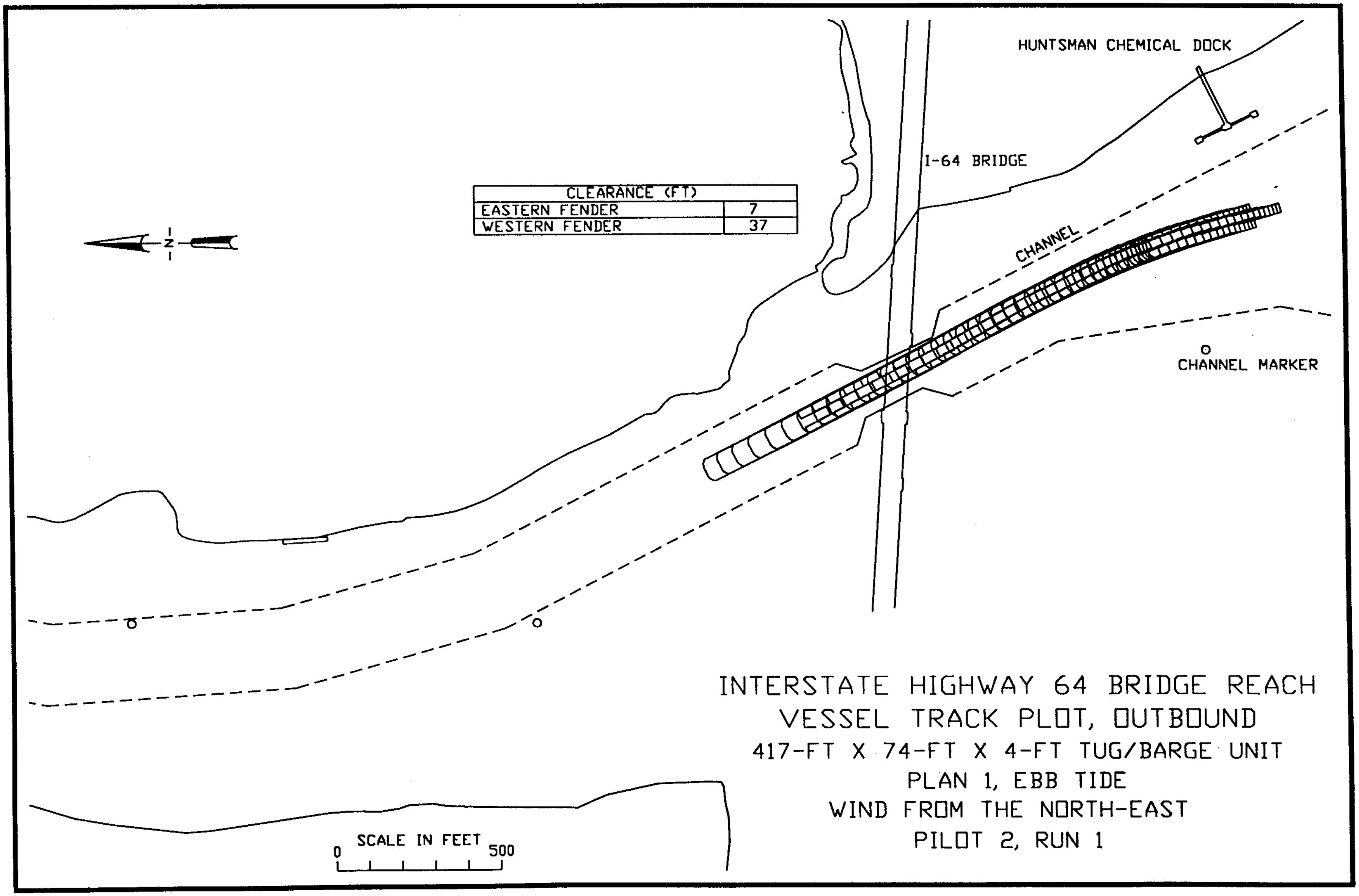

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
CHANNEL
I-64 BRIDGE
CLEARANCE (FT)
EASTERN FENDER 18
WESTERN FENDER 32
N
SCALE IN FEET
0
500

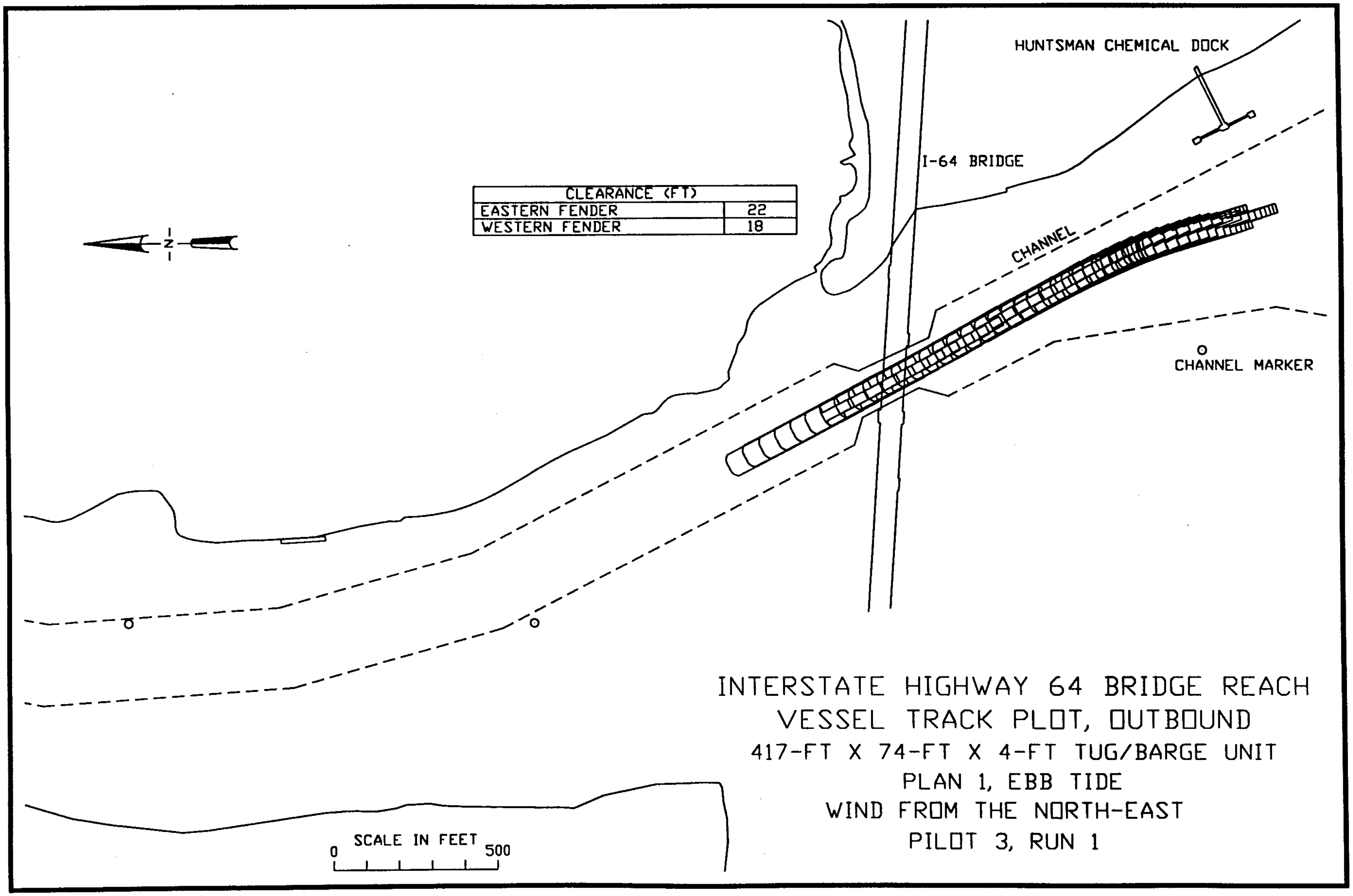
Plate 162



INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 23
WESTERN FENDER 35
SCALE IN FEET
0
500
N



CLEARANCE (FT)	
EASTERN FENDER	7
WESTERN FENDER	37



CLEARANCE (FT)	
EASTERN FENDER	22
WESTERN FENDER	18

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1

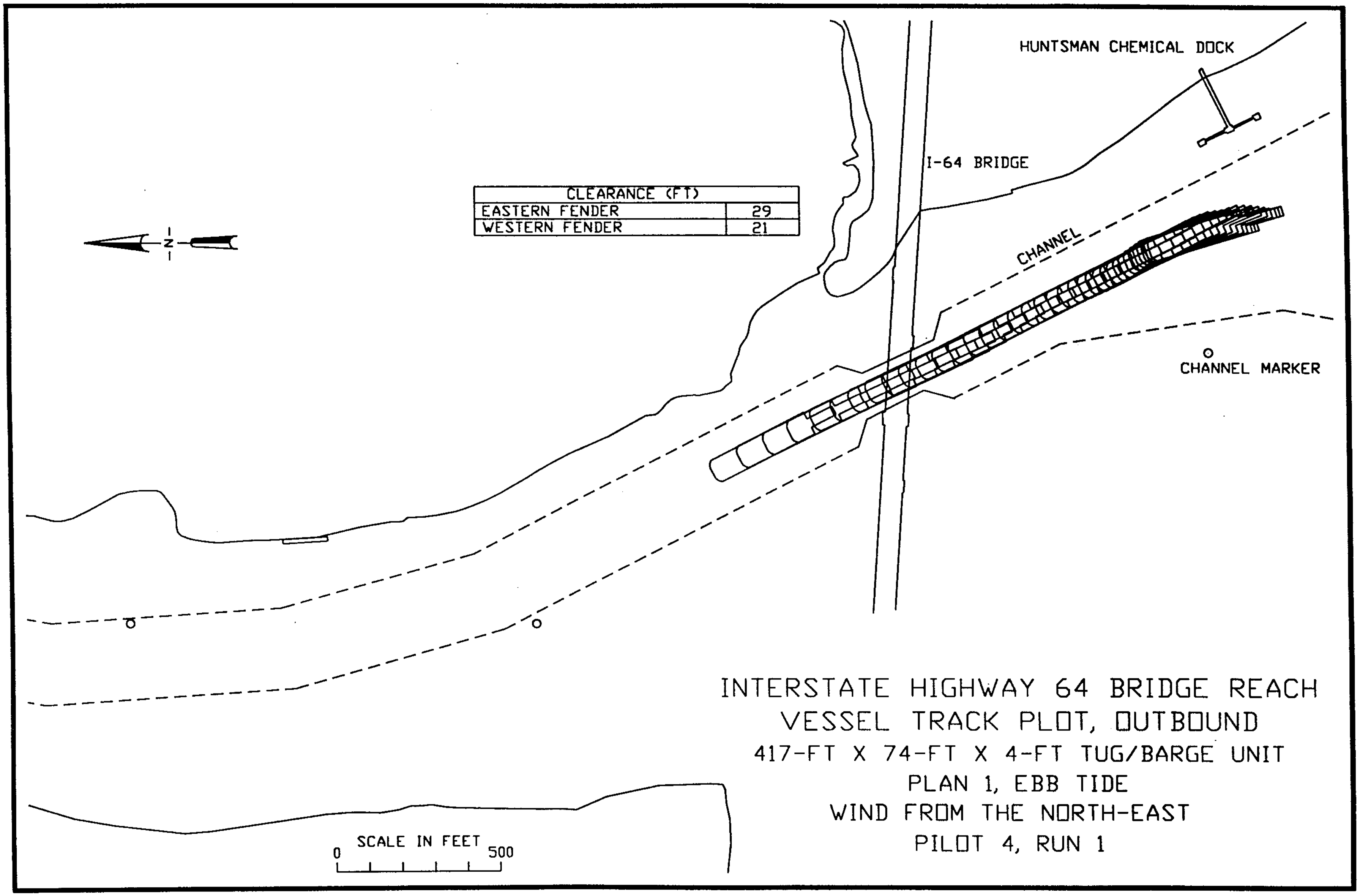
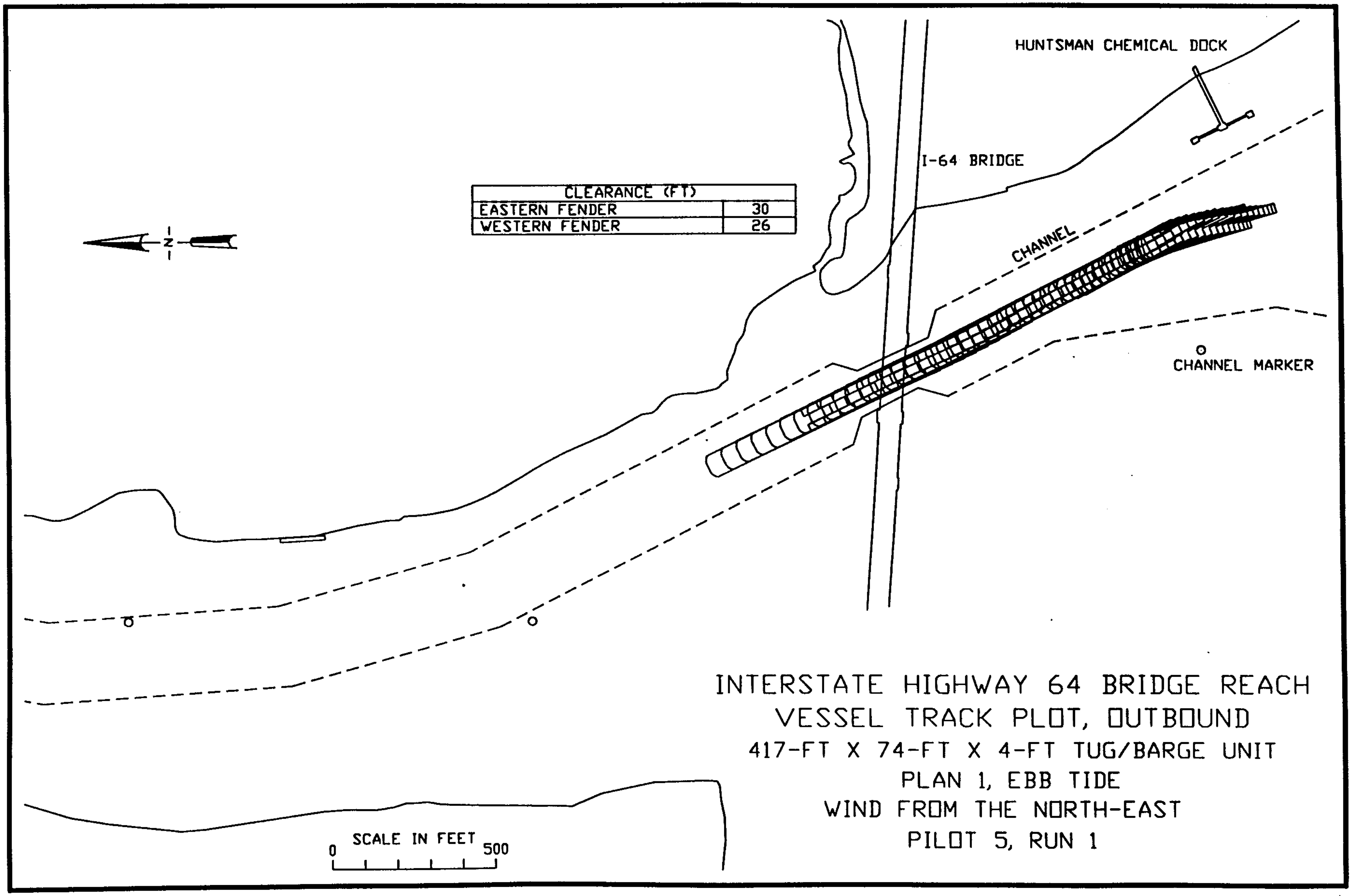
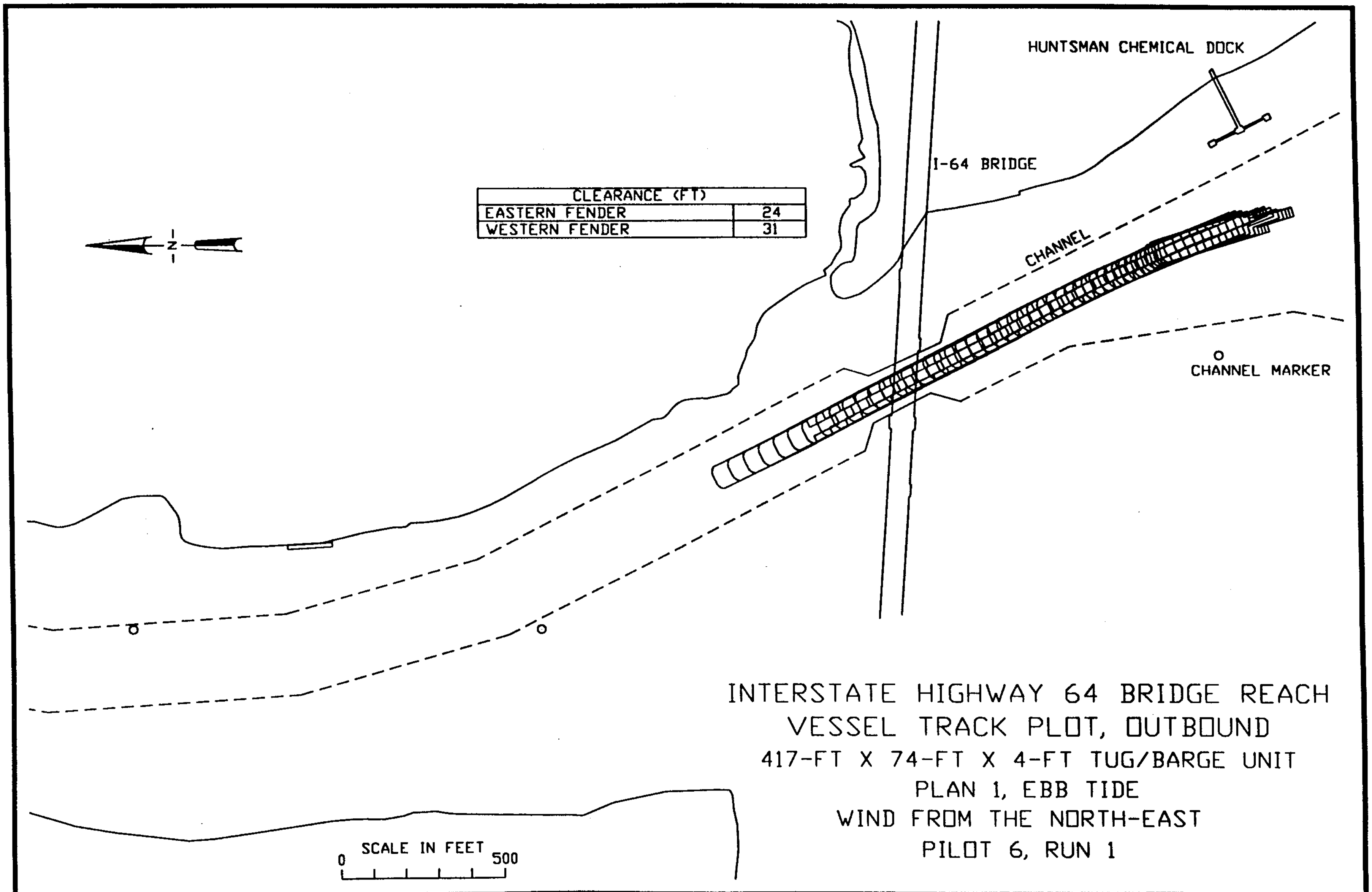

HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CLEARANCE (FT)
EASTERN FENDER 29
WESTERN FENDER 21
CHANNEL
CHANNEL MARKER
N
0 SCALE IN FEET 500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1

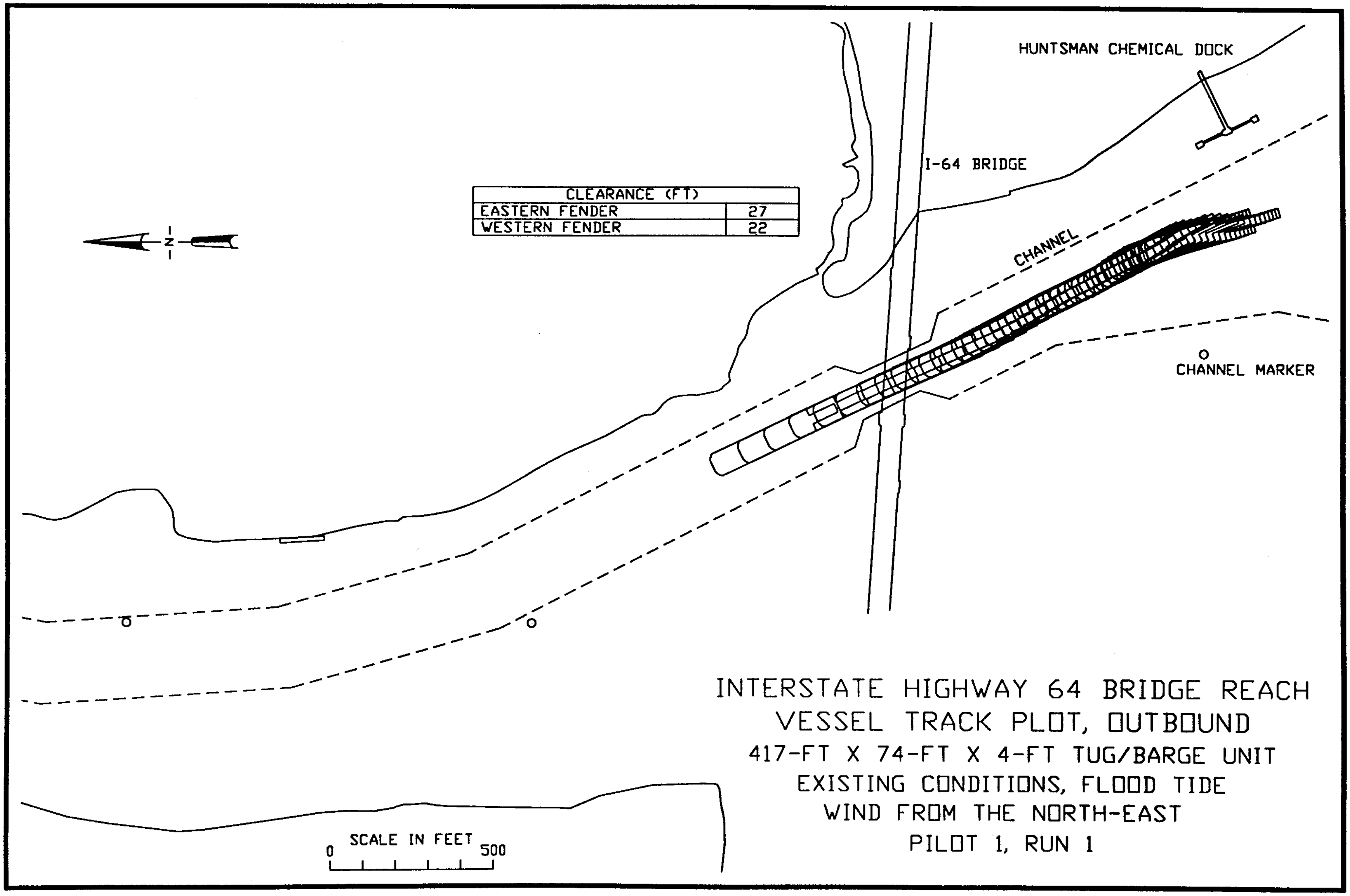
Plate 166



CLEARANCE (FT)	
EASTERN FENDER	30
WESTERN FENDER	26



INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, EBB TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1



INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1

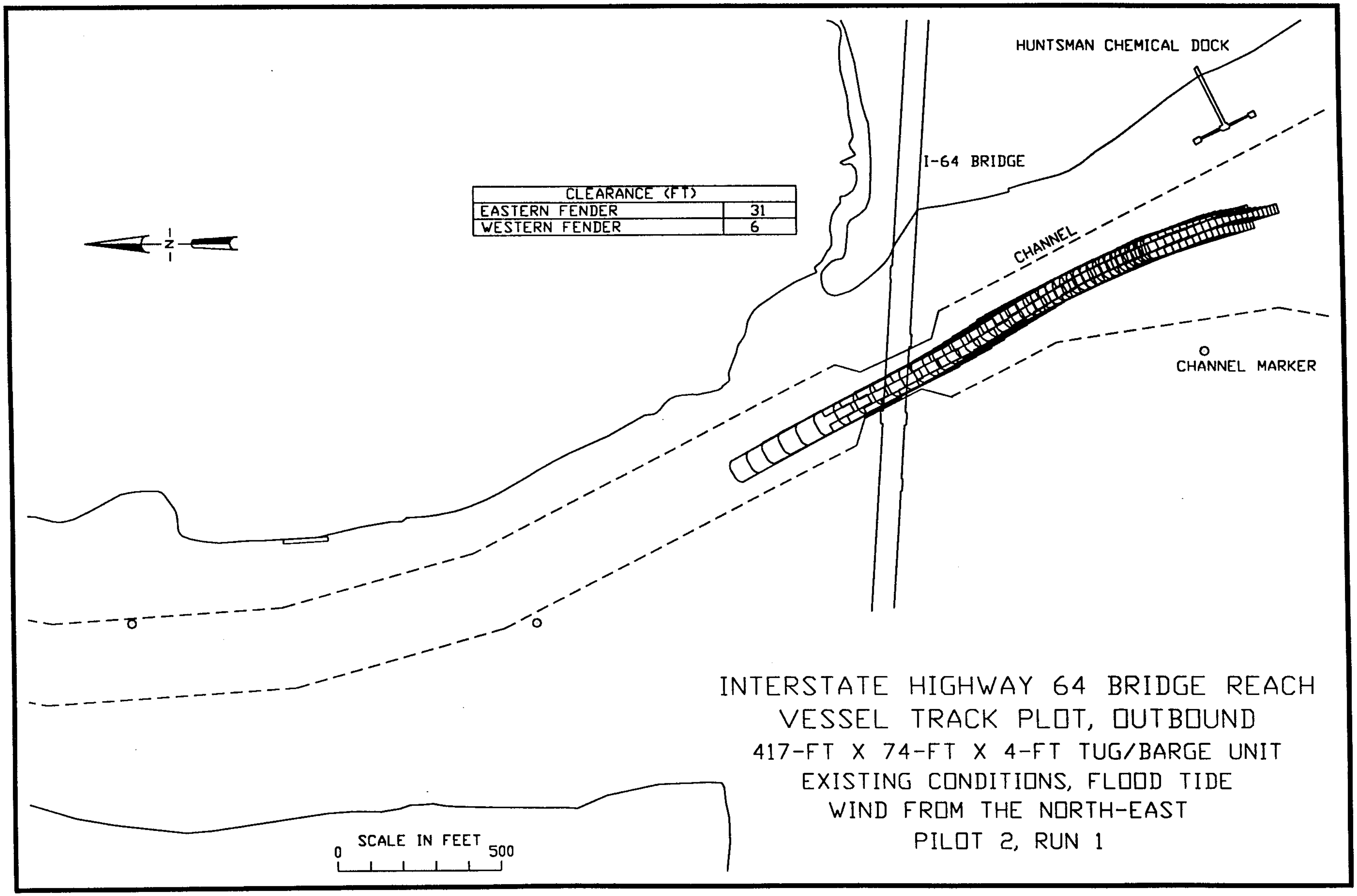
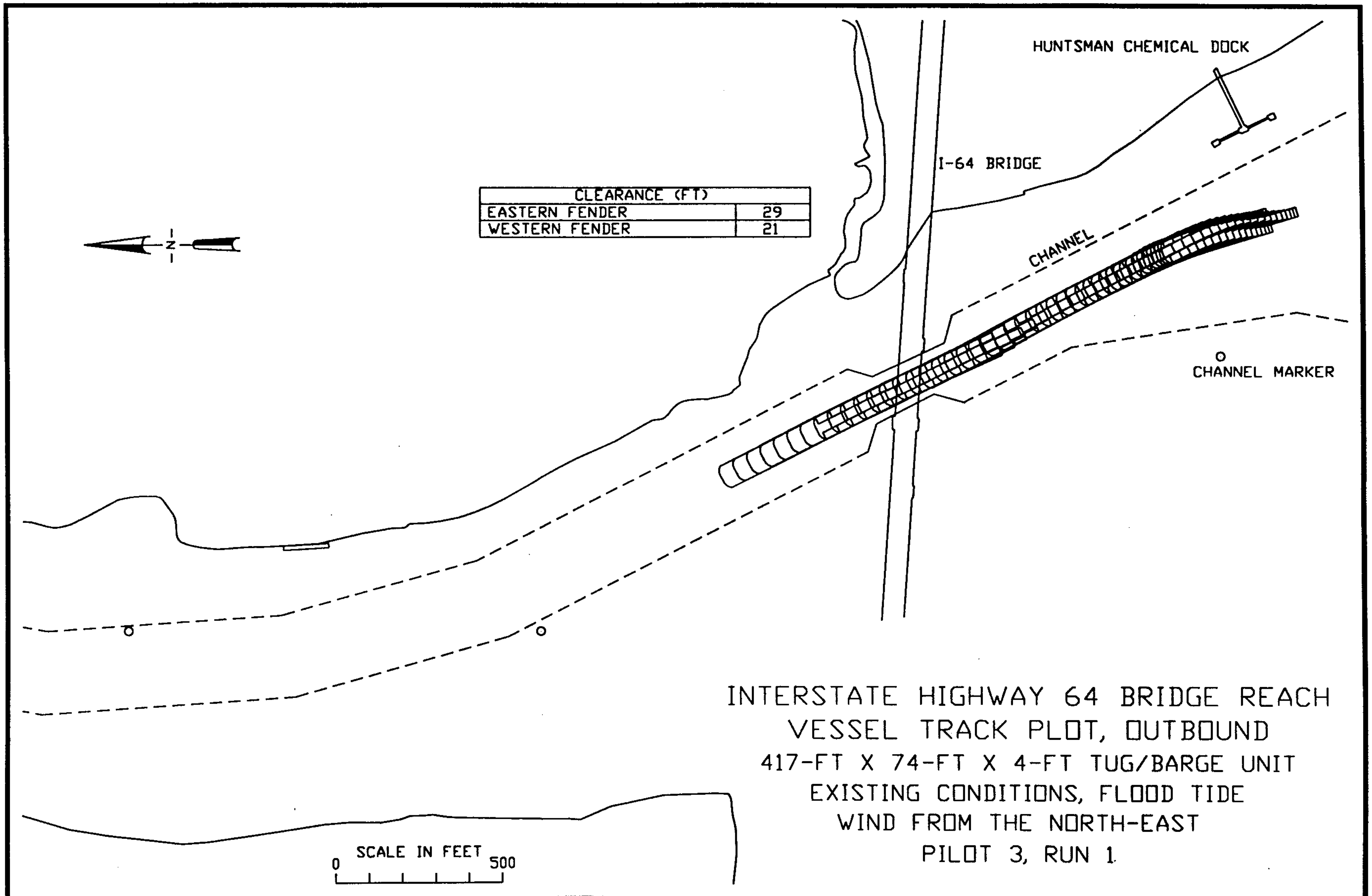

HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 31
WESTERN FENDER 6
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1

Plate 170



CLEARANCE (FT)	
EASTERN FENDER	29
WESTERN FENDER	21

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1

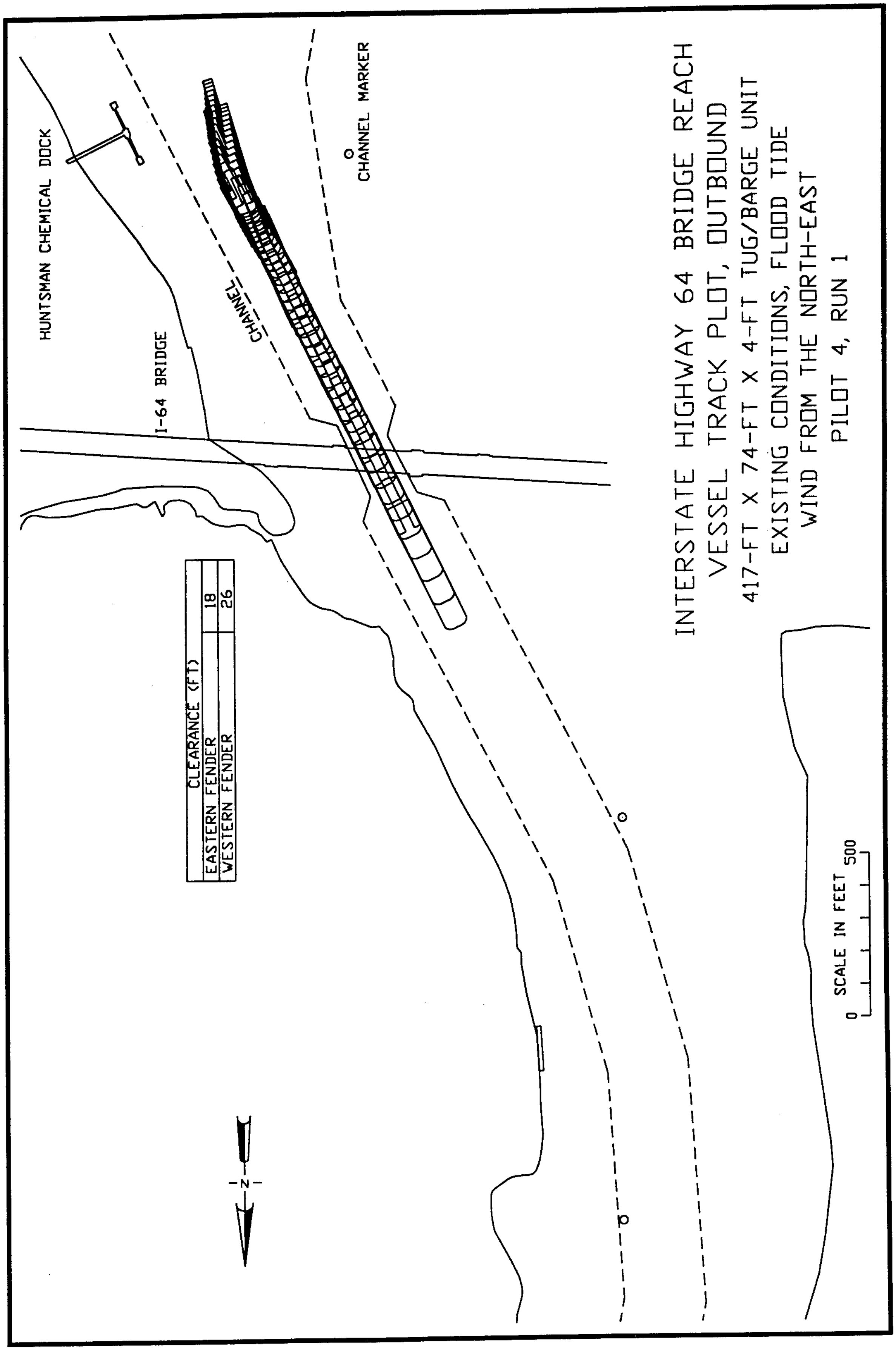
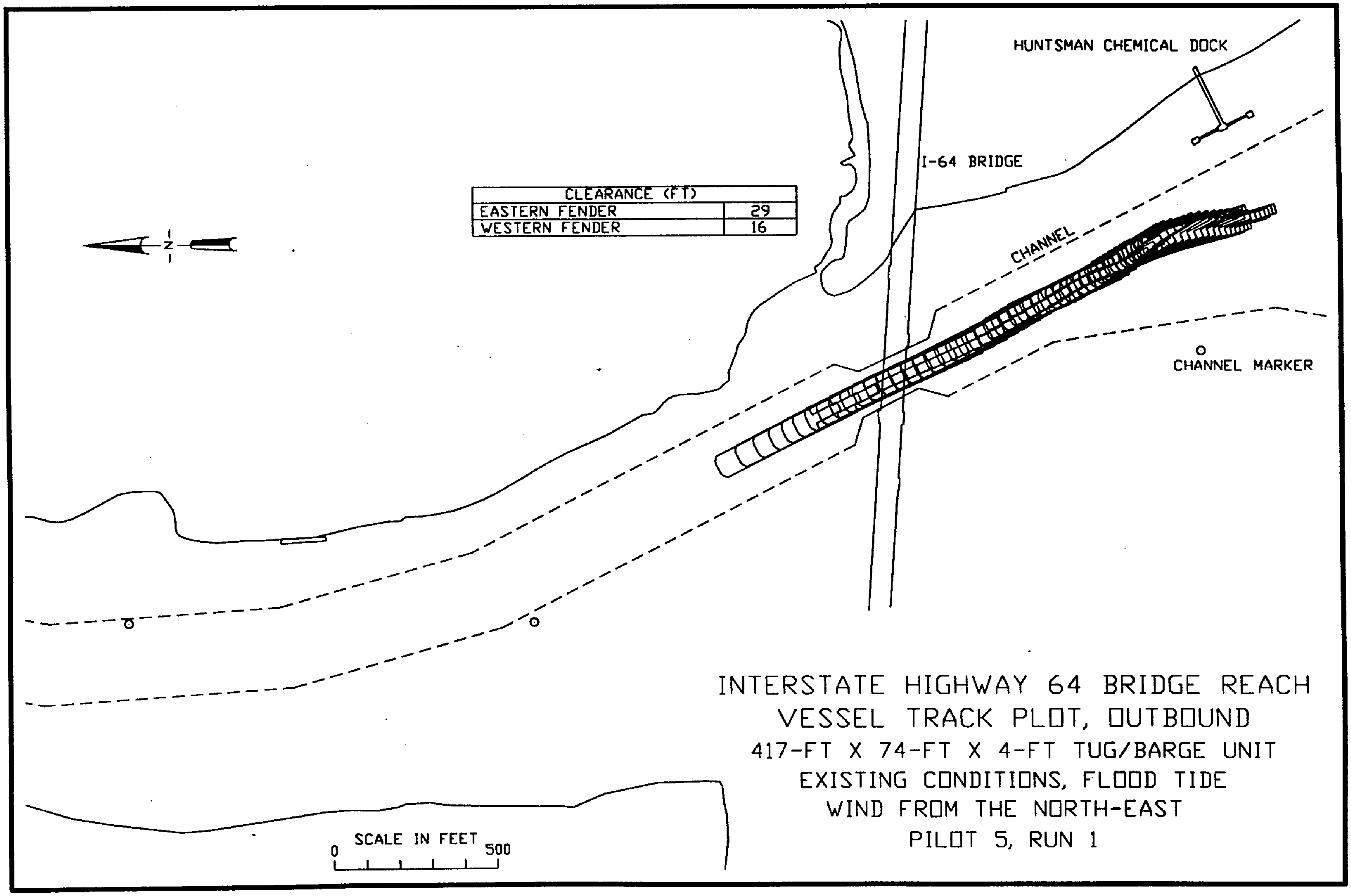
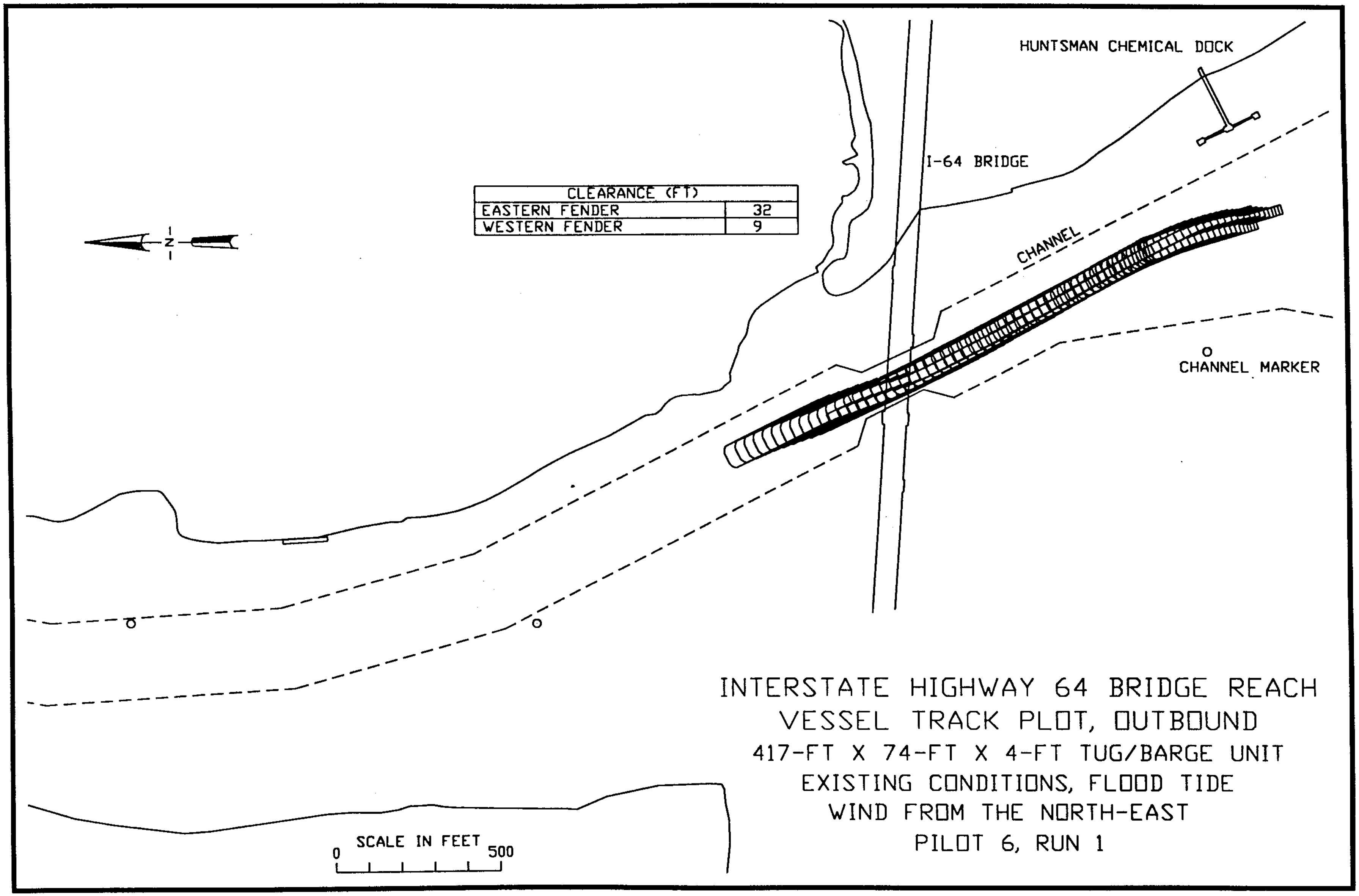

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 18
WESTERN FENDER 26
SCALE IN FEET
0
500
N

Plate 172

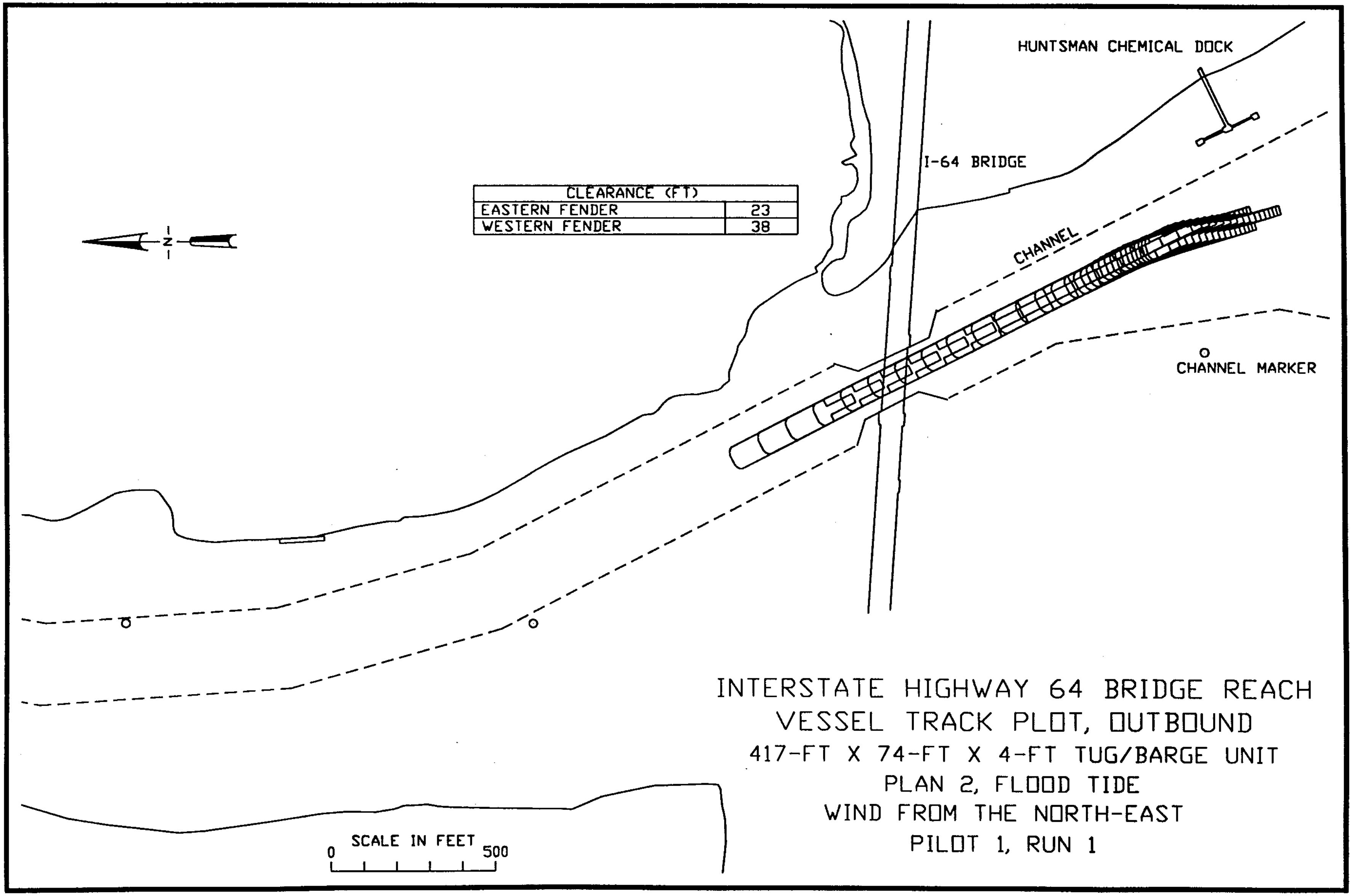


CLEARANCE (FT)	
EASTERN FENDER	29
WESTERN FENDER	16

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1

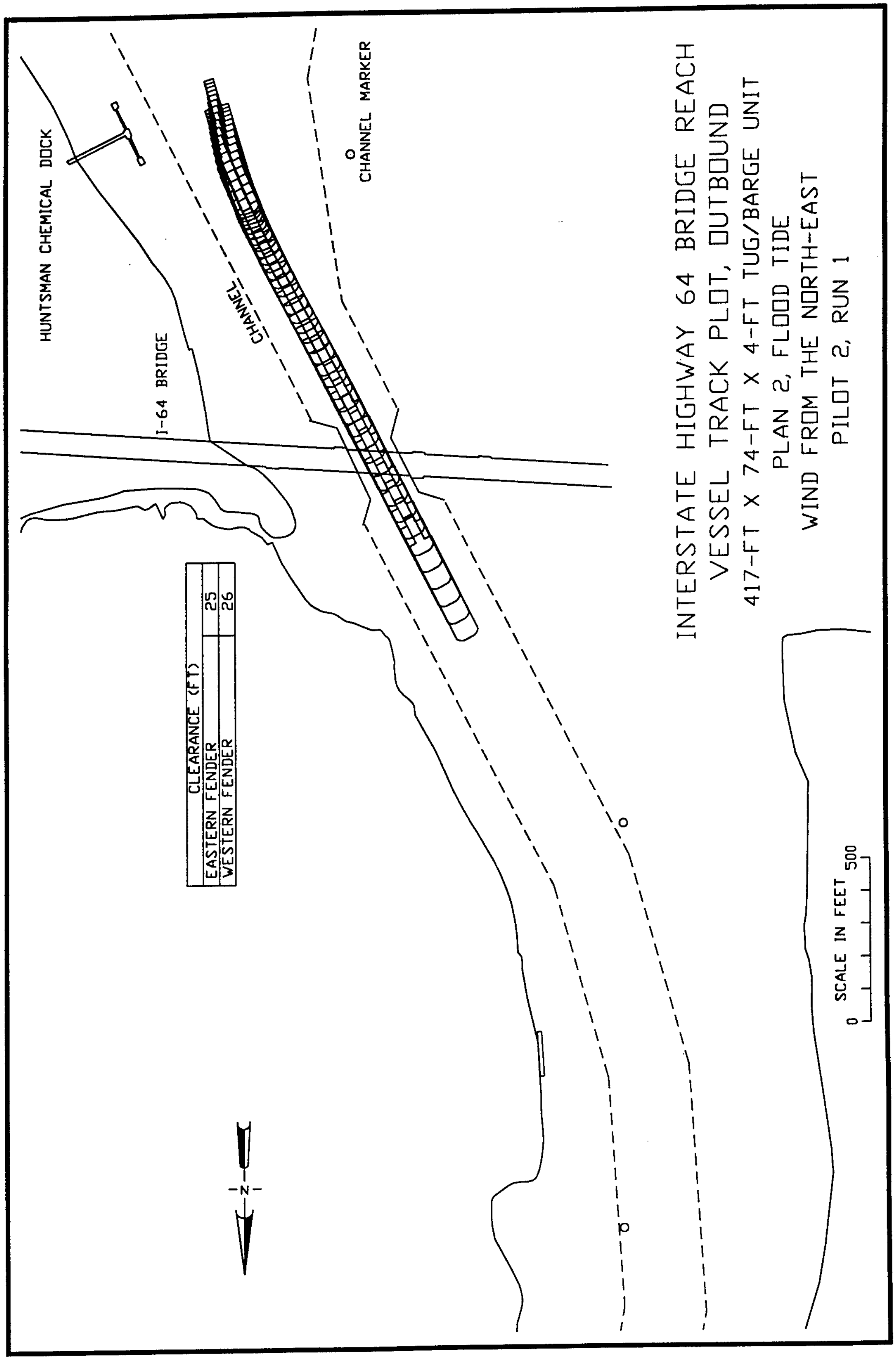


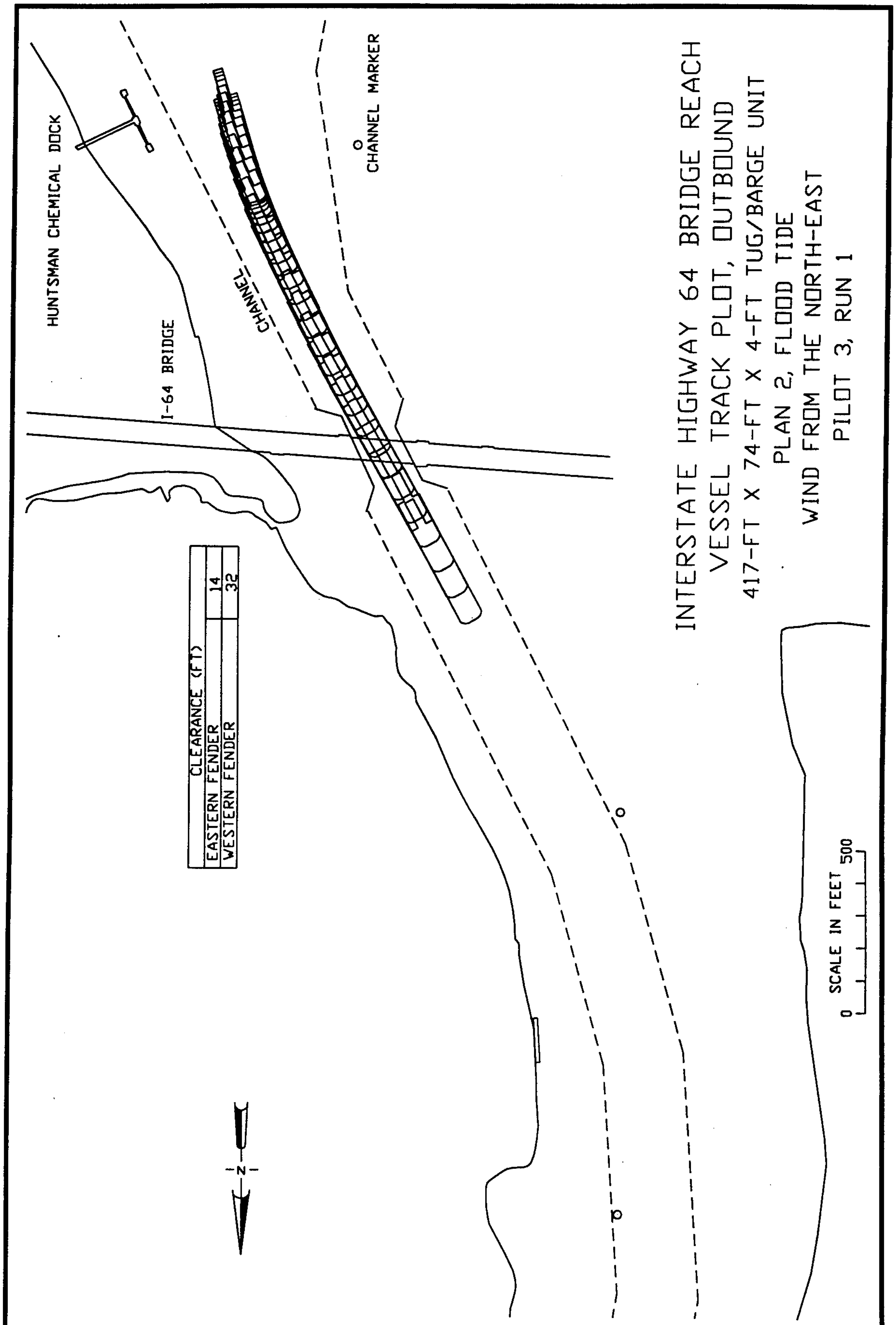
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
EXISTING CONDITIONS, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1



CLEARANCE (FT)	
EASTERN FENDER	23
WESTERN FENDER	38

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1
HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 25
WESTERN FENDER 26
SCALE IN FEET
0
500
N


INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 3, RUN 1
HUNTSMAN CHEMICAL DOCK
CHANNEL MARKER
I-64 BRIDGE
CHANNEL
CLEARANCE (FT)
EASTERN FENDER 14
WESTERN FENDER 32
SCALE IN FEET
0
500
N

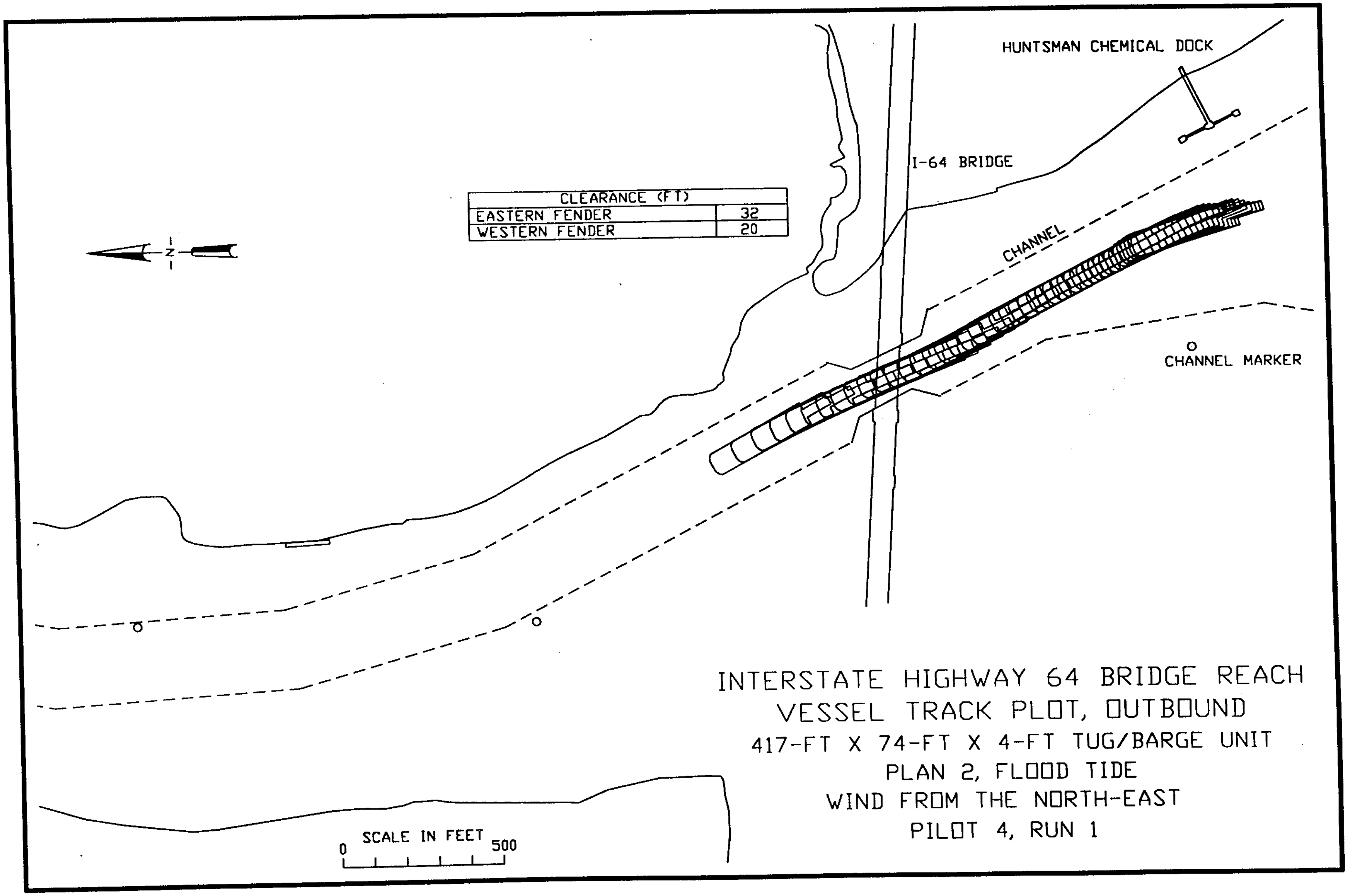
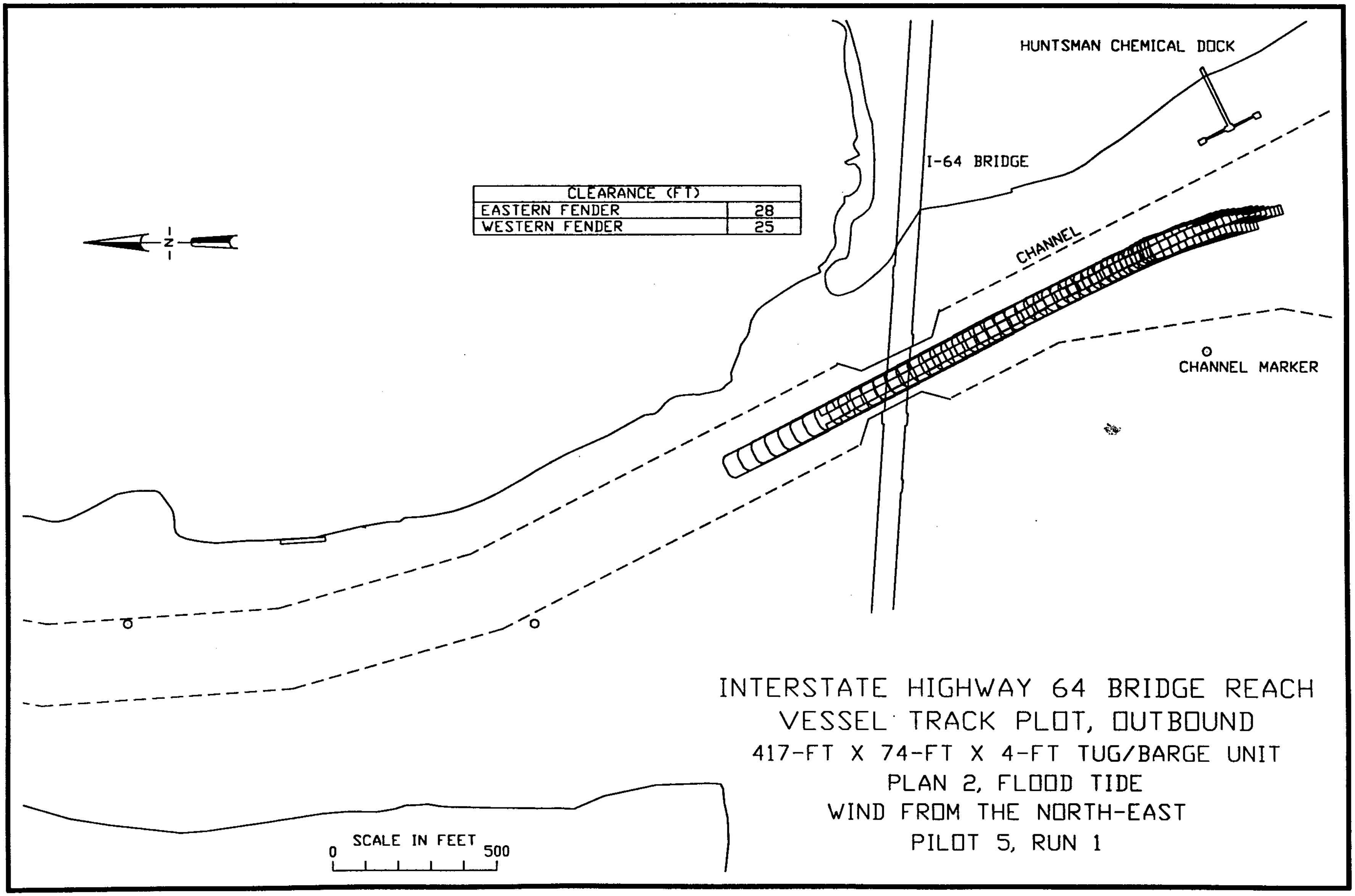
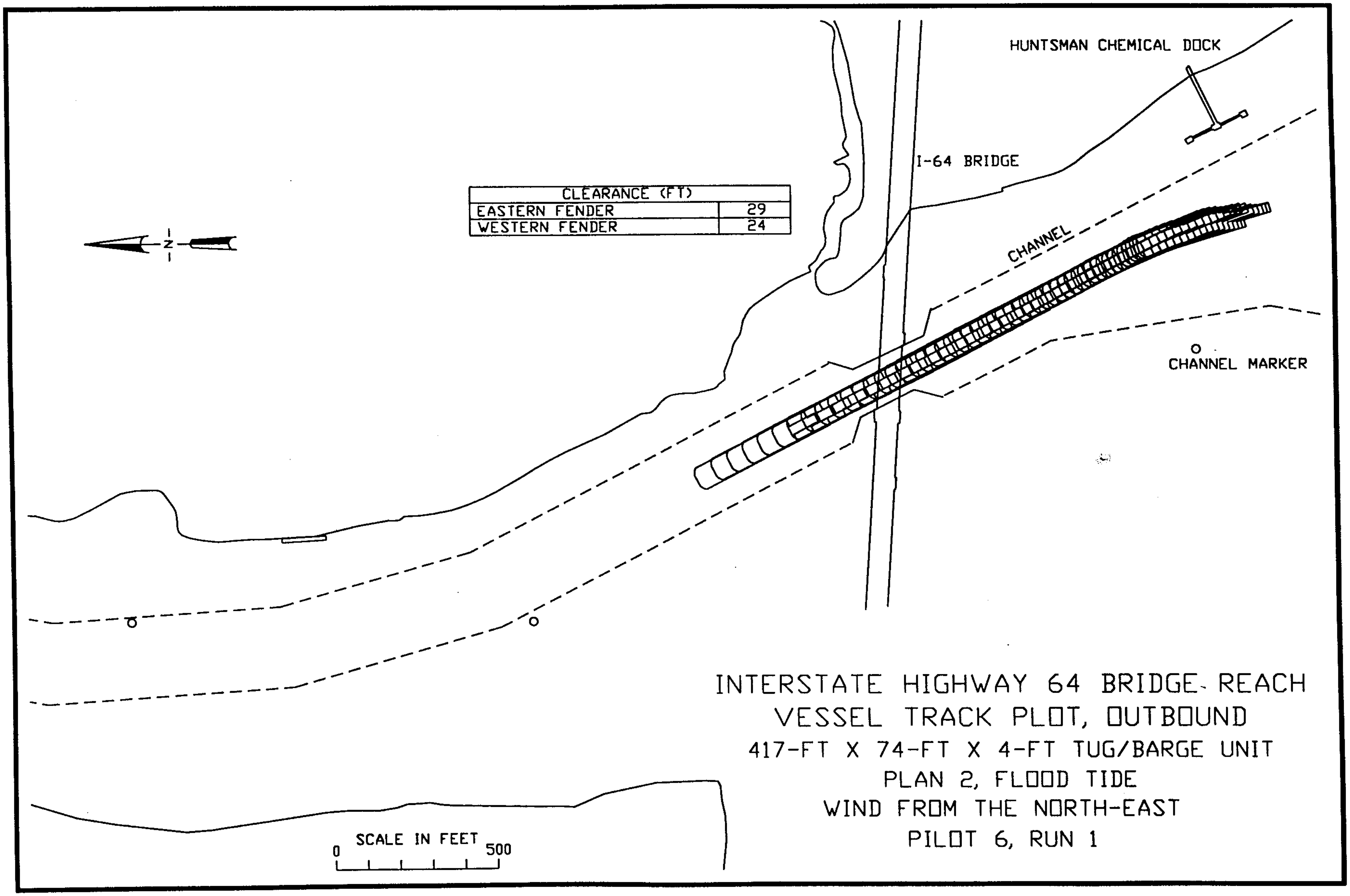

HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CLEARANCE (FT)
EASTERN FENDER 32
WESTERN FENDER 20
N
CHANNEL
CHANNEL MARKER
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1

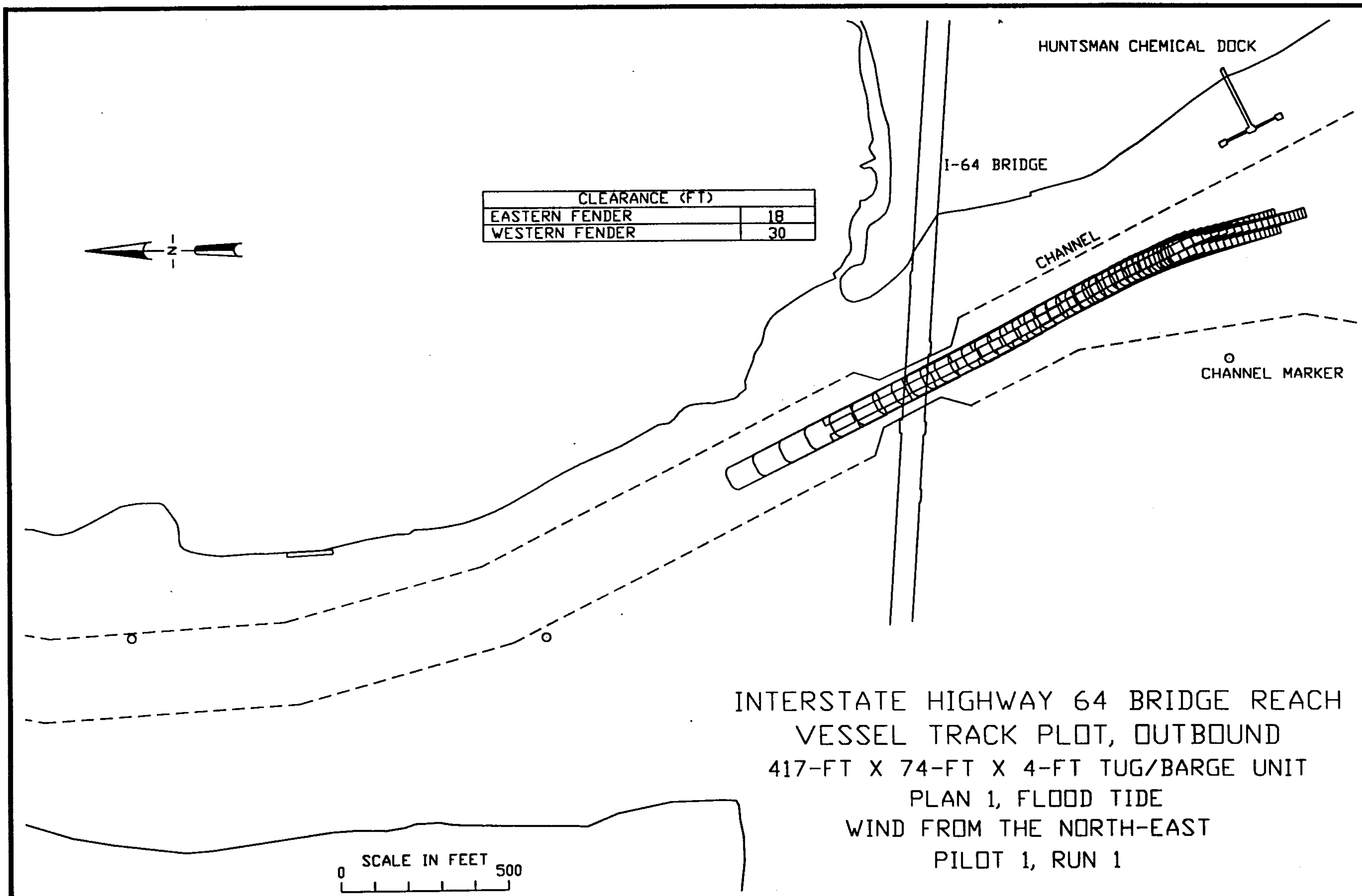
Plate 178



CLEARANCE (FT)	
EASTERN FENDER	28
WESTERN FENDER	25

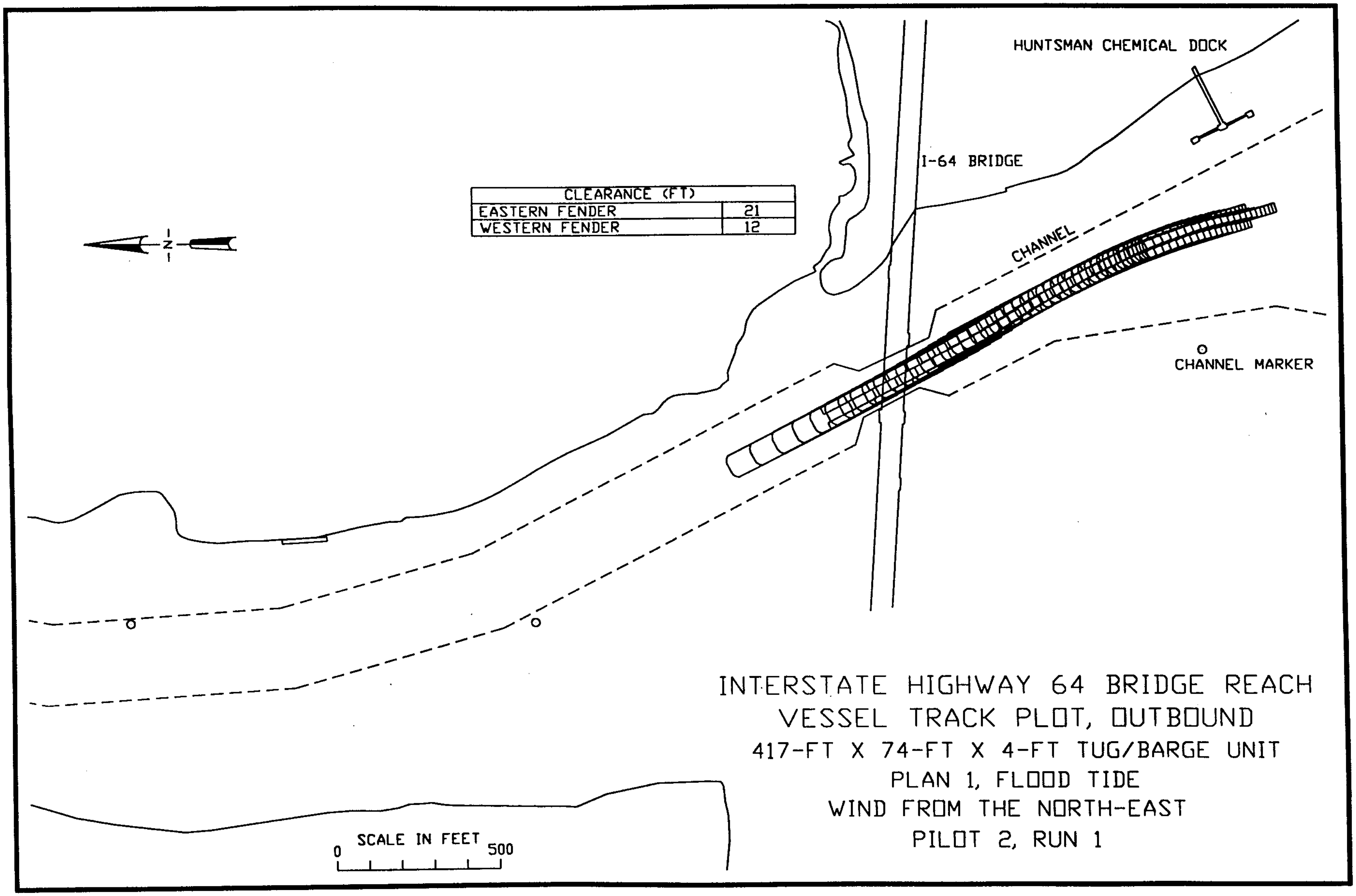
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1


HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 29
WESTERN FENDER 24
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 2, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1



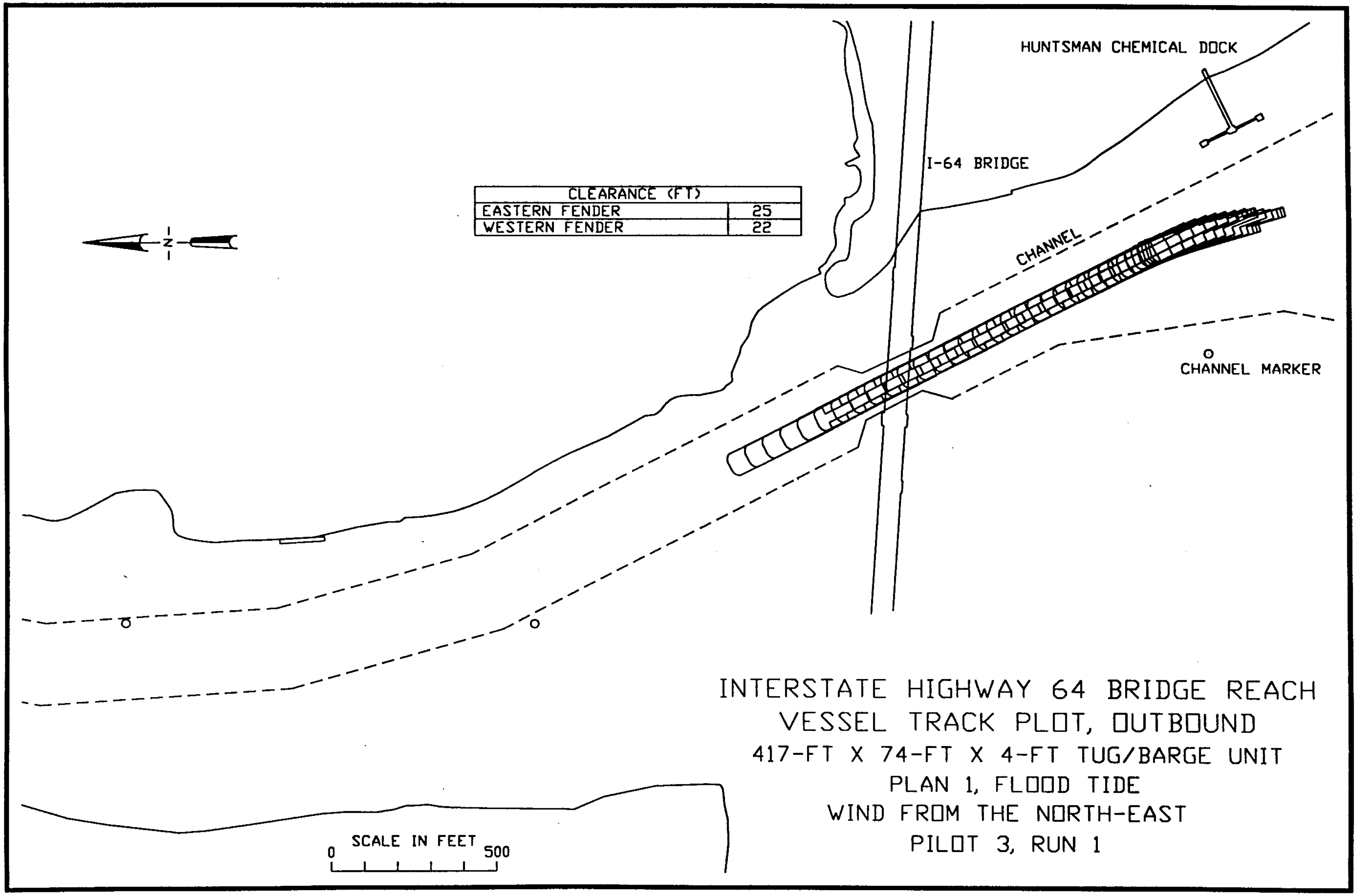
CLEARANCE (FT)	
EASTERN FENDER	18
WESTERN FENDER	30

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 1, RUN 1

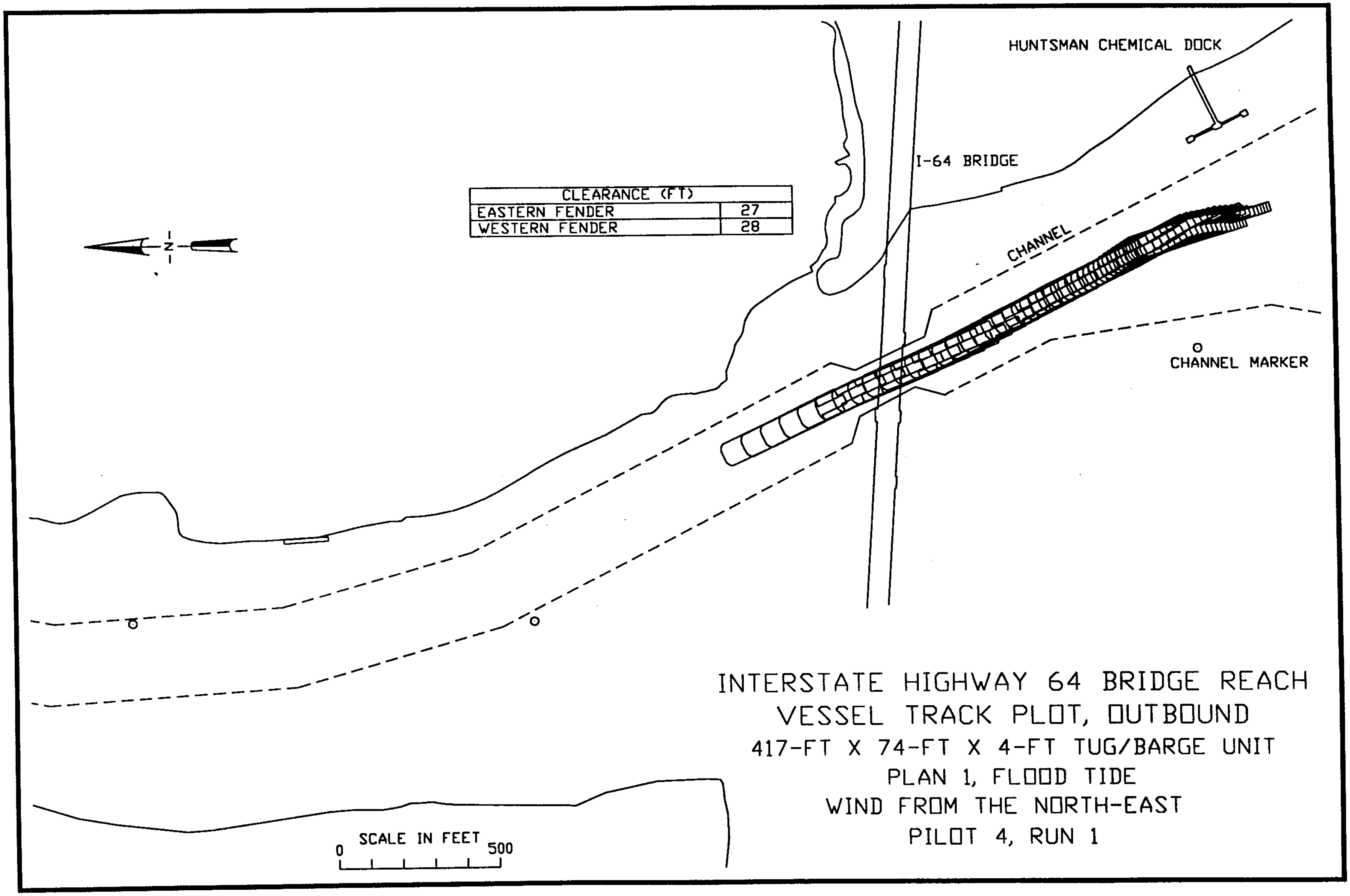


CLEARANCE (FT)	
EASTERN FENDER	21
WESTERN FENDER	12

INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 2, RUN 1

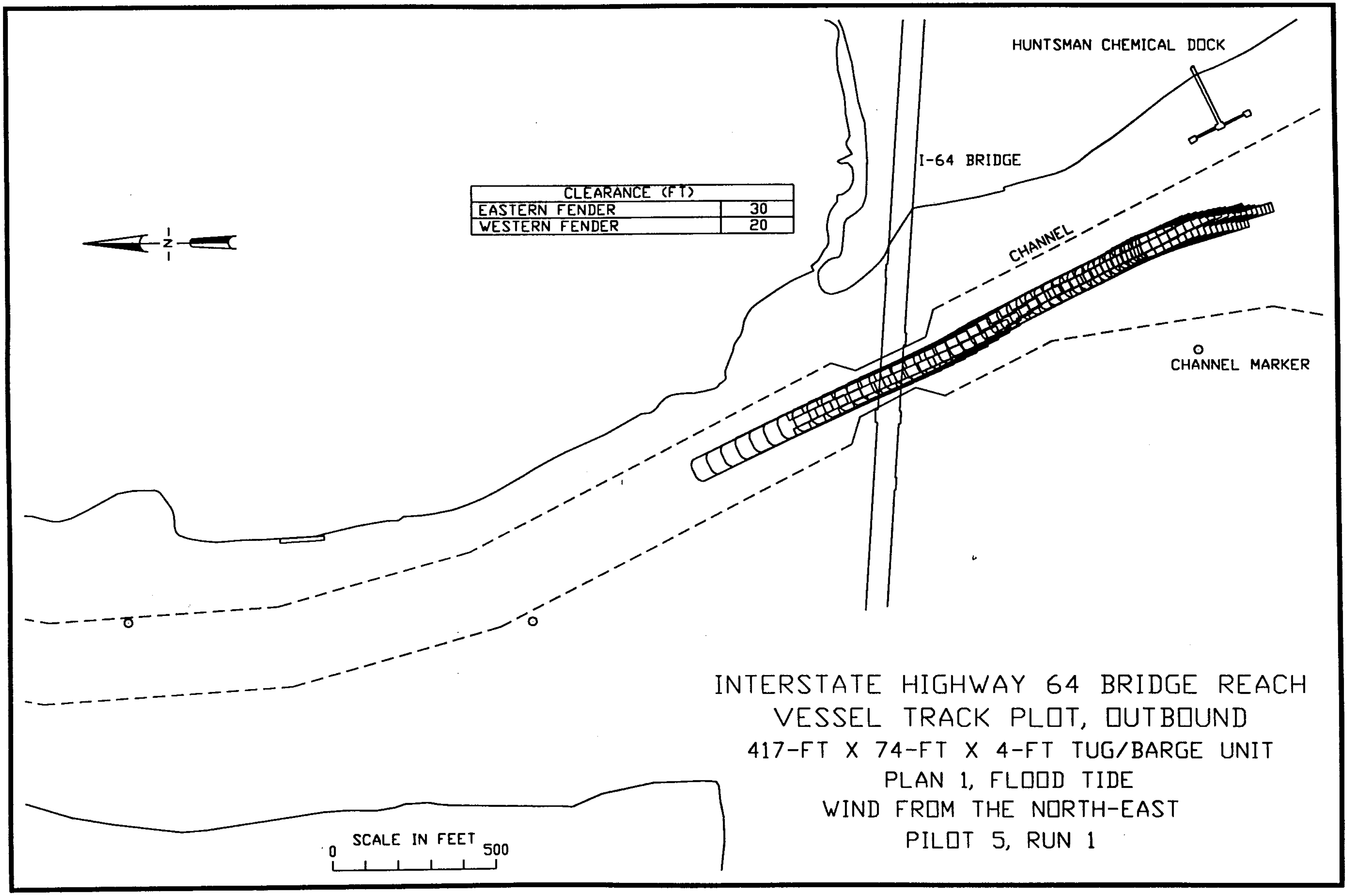


CLEARANCE (FT)	
EASTERN FENDER	25
WESTERN FENDER	22



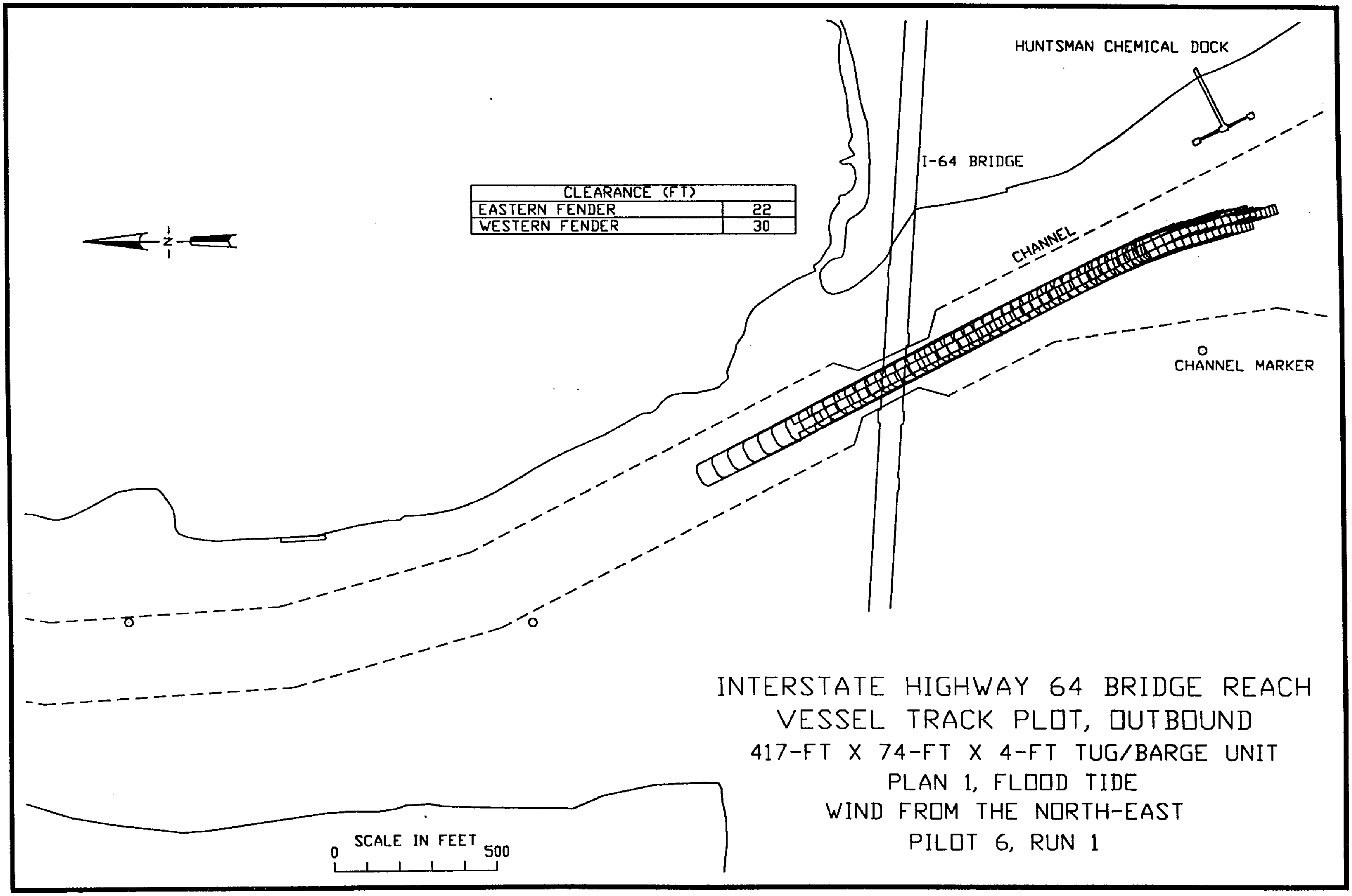
CLEARANCE (FT)	
EASTERN FENDER	27
WESTERN FENDER	28

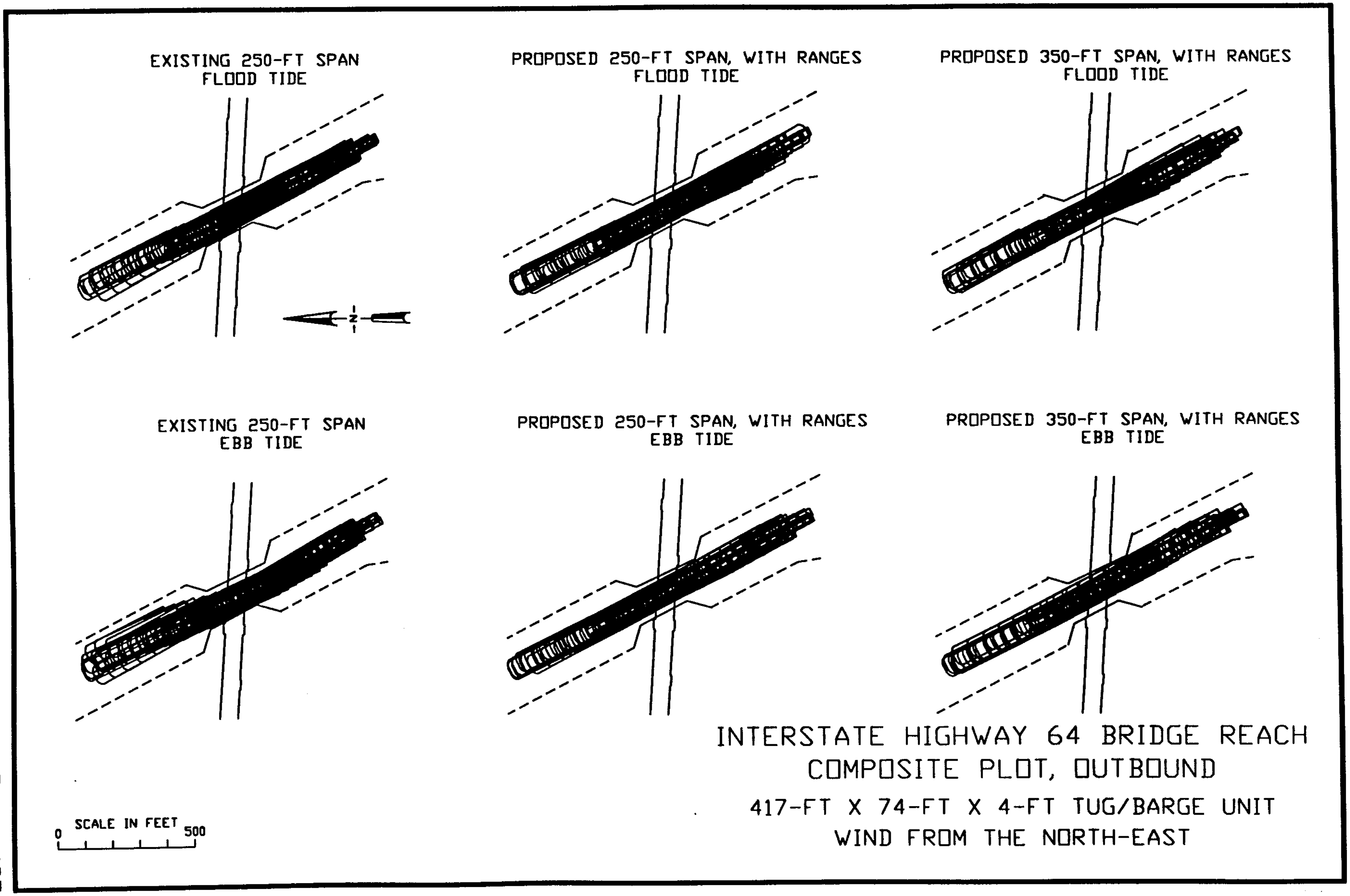
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 4, RUN 1



CLEARANCE (FT)	
EASTERN FENDER	30
WESTERN FENDER	20

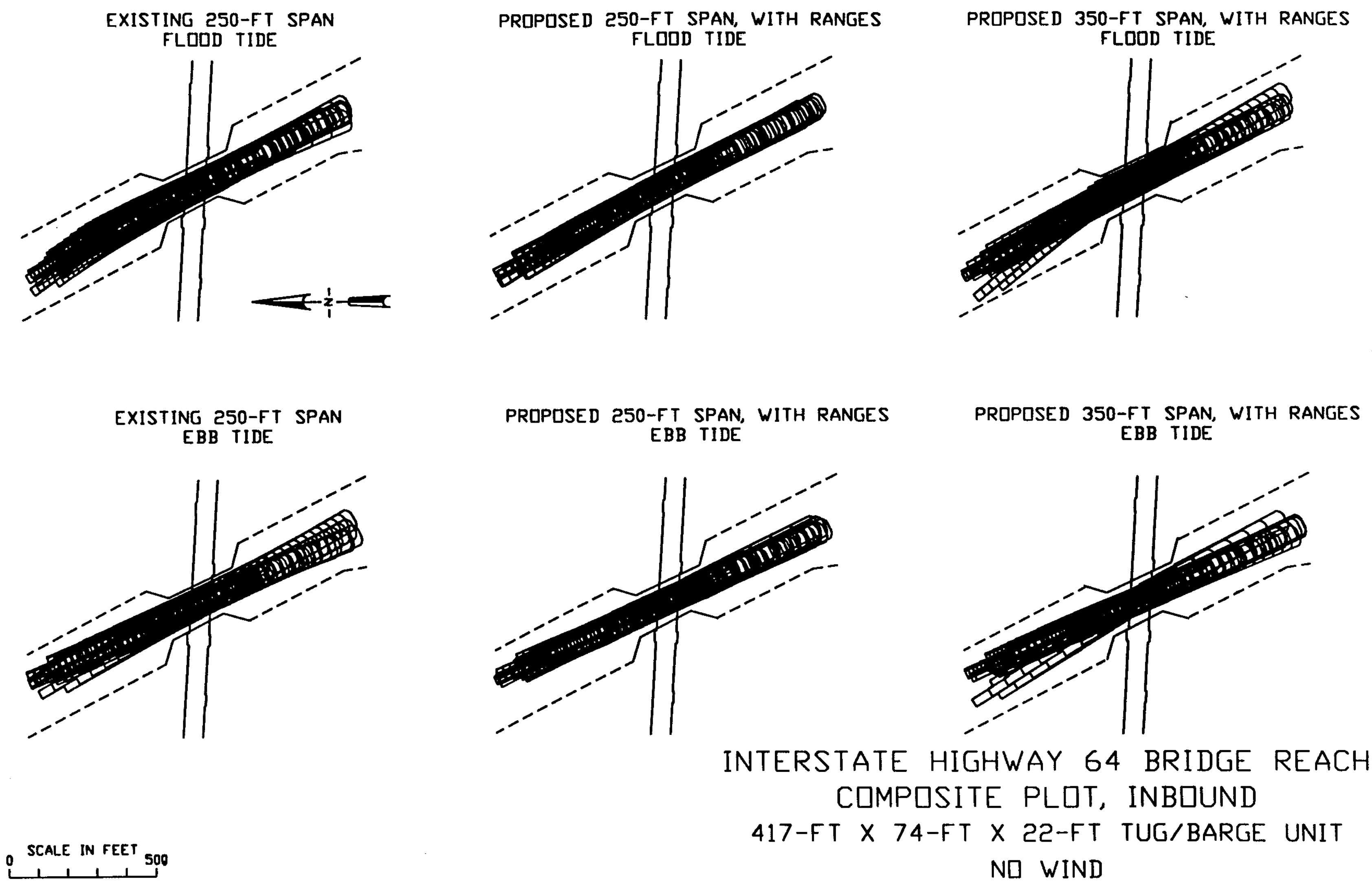
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 5, RUN 1


HUNTSMAN CHEMICAL DOCK
I-64 BRIDGE
CHANNEL
CHANNEL MARKER
CLEARANCE (FT)
EASTERN FENDER 22
WESTERN FENDER 30
N
SCALE IN FEET
0
500
INTERSTATE HIGHWAY 64 BRIDGE REACH
VESSEL TRACK PLOT, OUTBOUND
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
PLAN 1, FLOOD TIDE
WIND FROM THE NORTH-EAST
PILOT 6, RUN 1

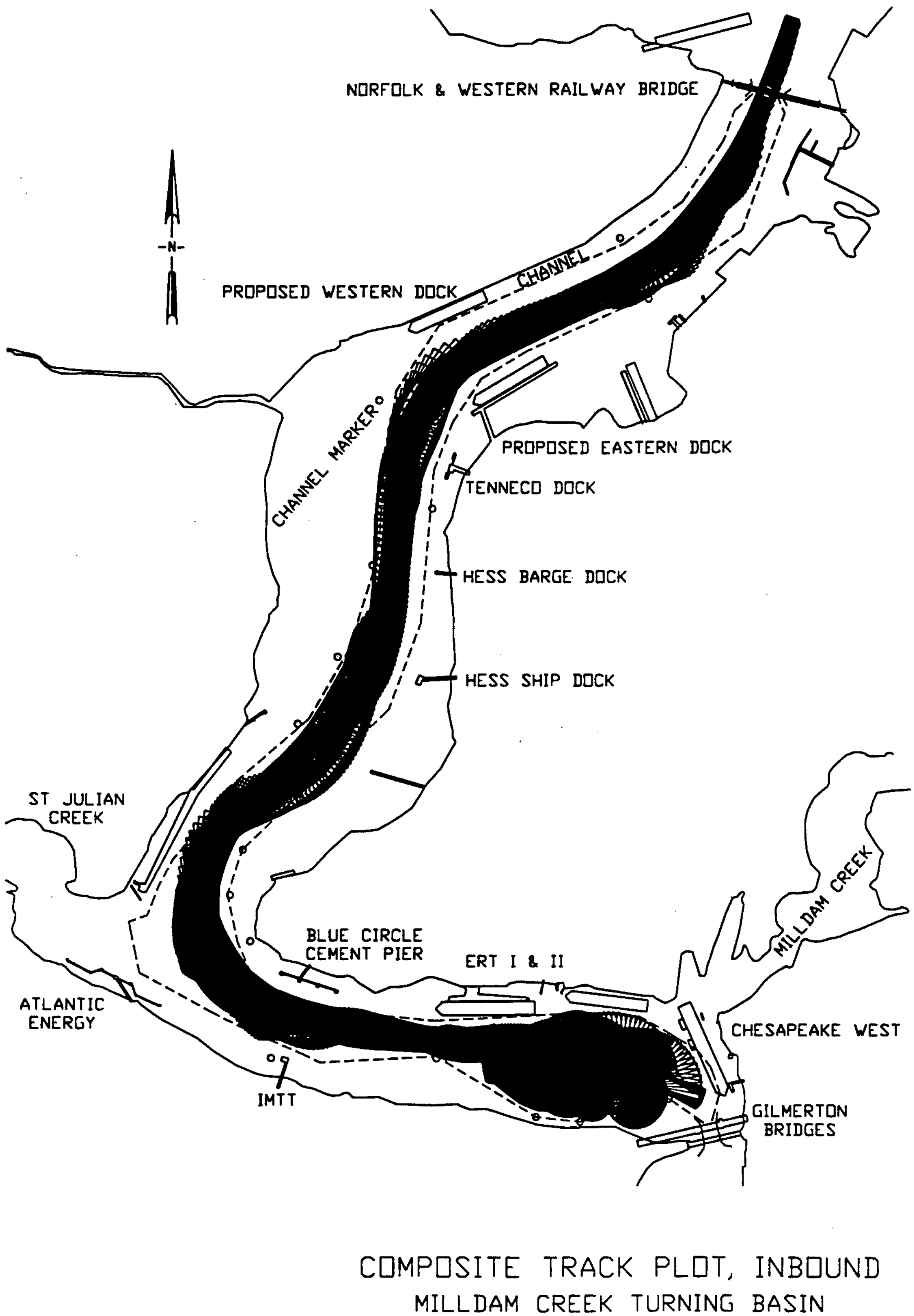


INTERSTATE HIGHWAY 64 BRIDGE REACH
COMPOSITE PLOT, OUTBOUND

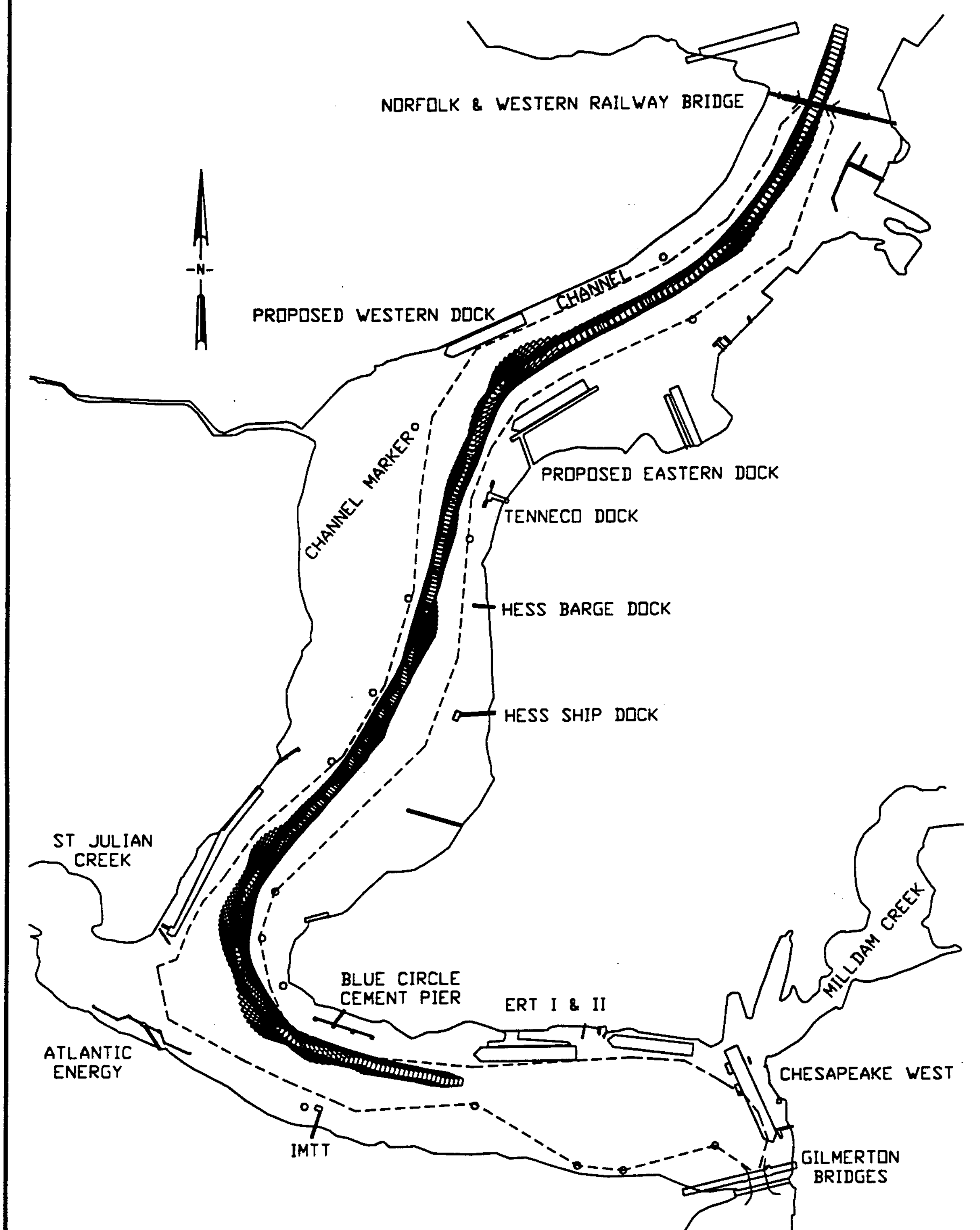
417-FT X 74-FT X 4-FT TUG/BARGE UNIT
WIND FROM THE NORTH-EAST



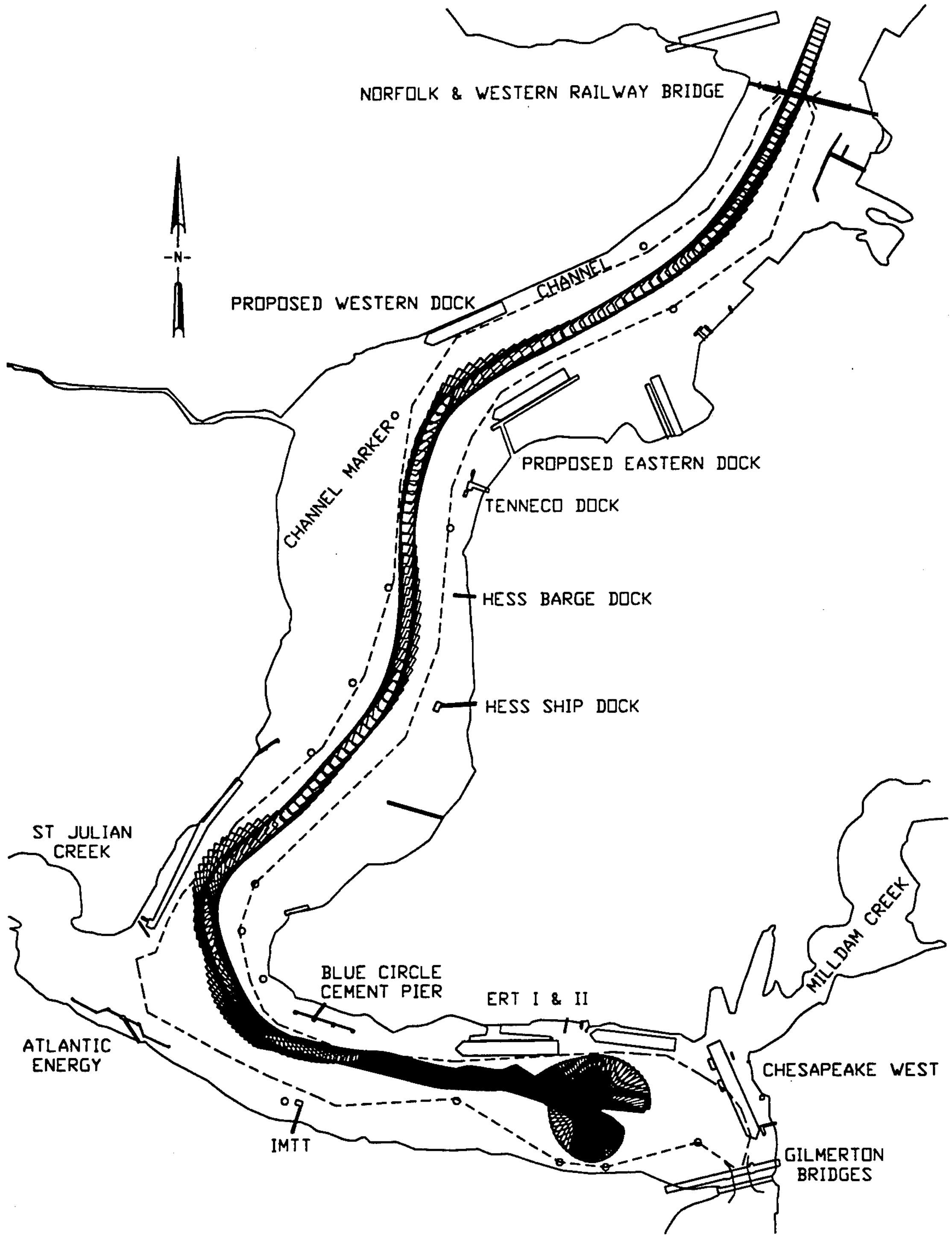
INTERSTATE HIGHWAY 64 BRIDGE REACH
COMPOSITE PLOT, INBOUND
417-FT X 74-FT X 22-FT TUG/BARGE UNIT
NO WIND



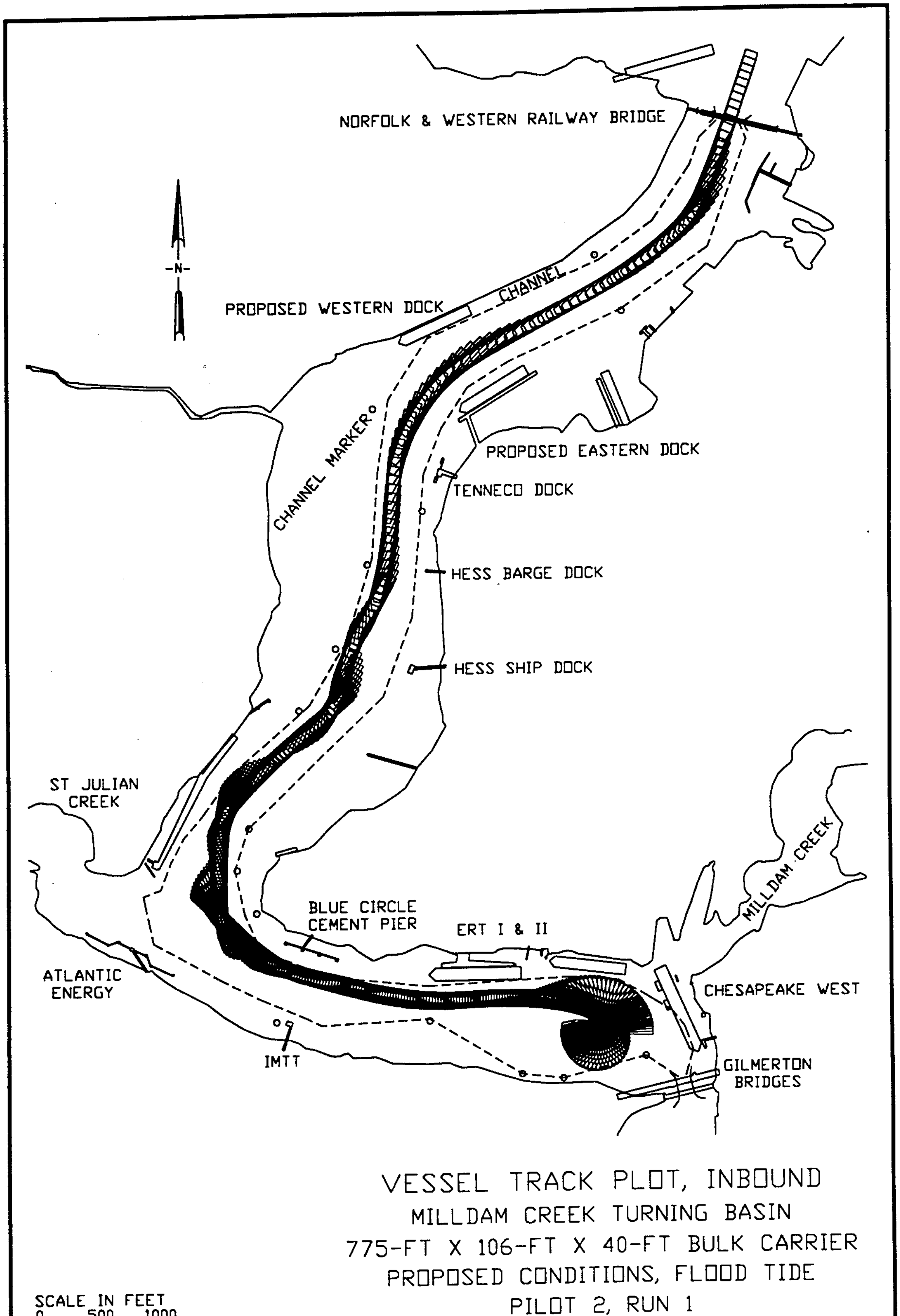
COMPOSITE TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE



VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 1, RUN 1

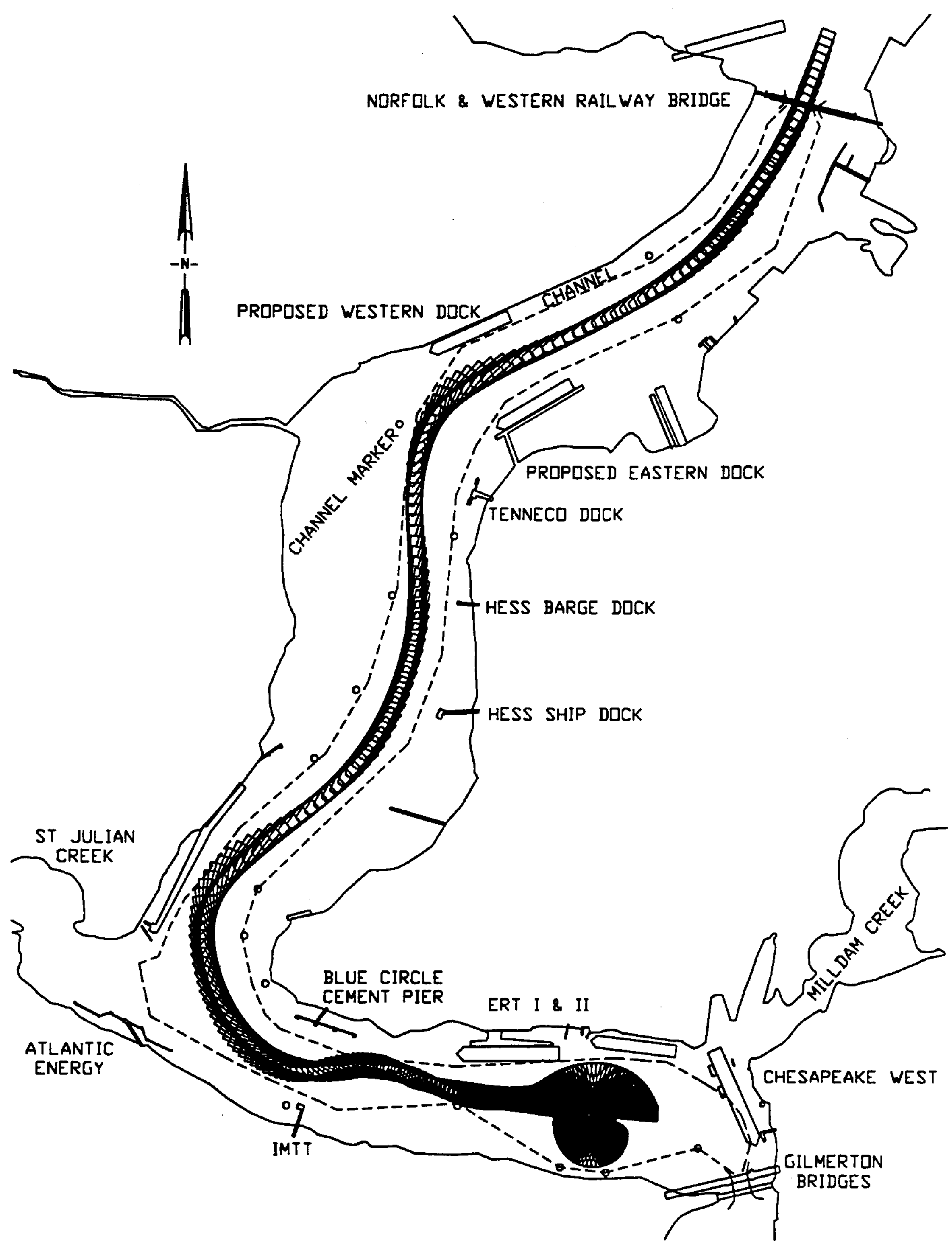


VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 1, RUN 2

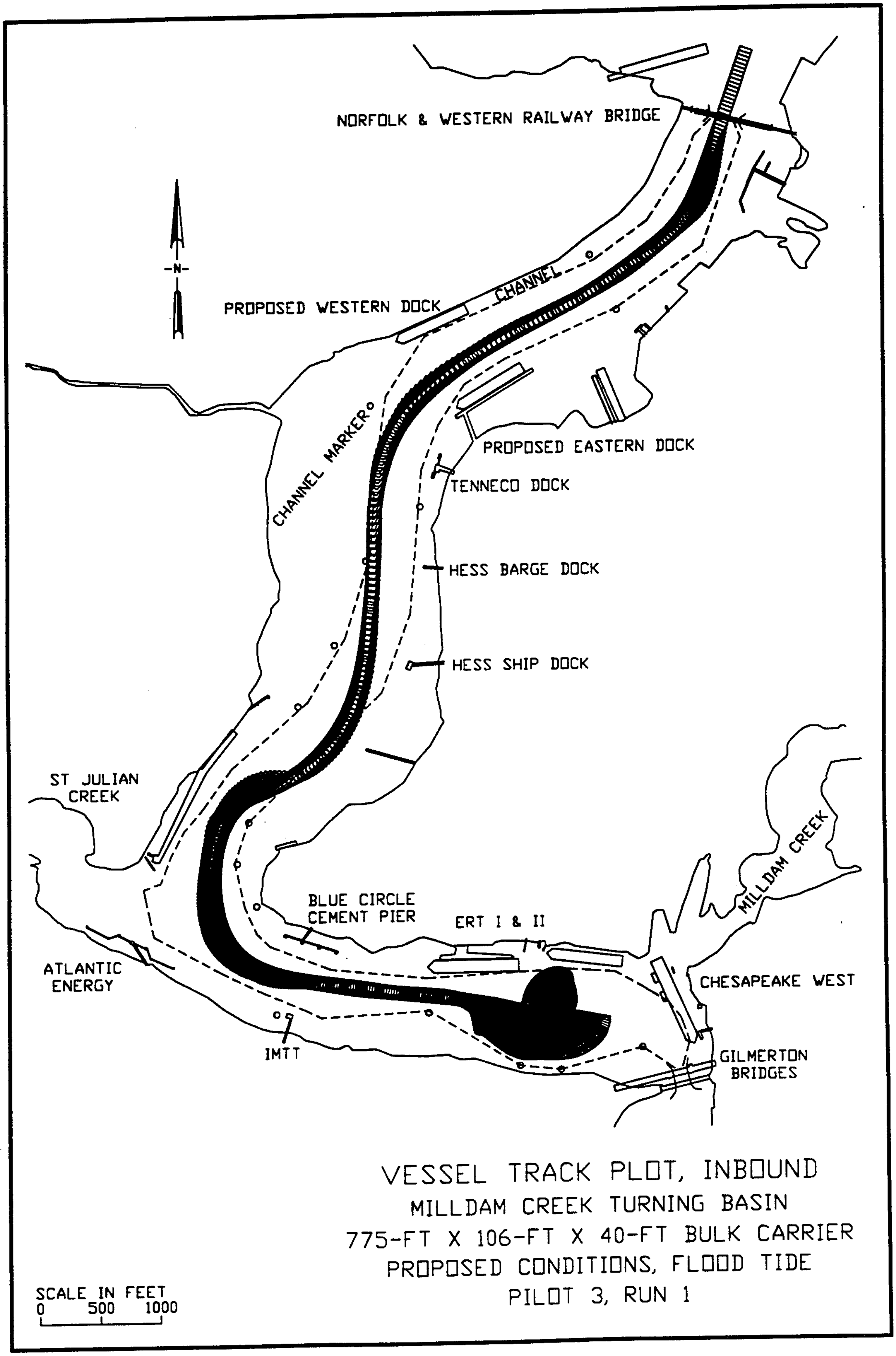


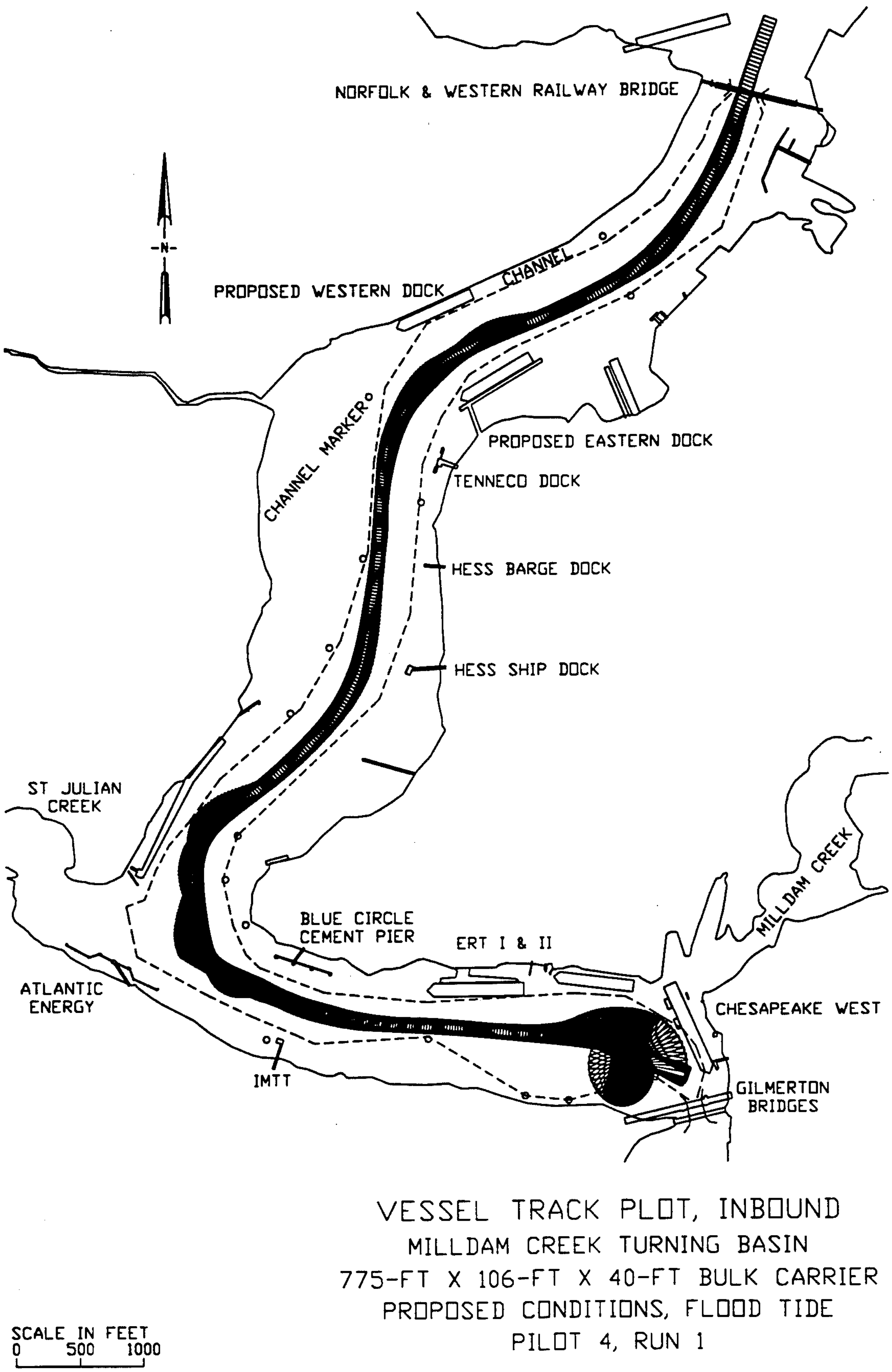
VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 2, RUN 1

Plate 192

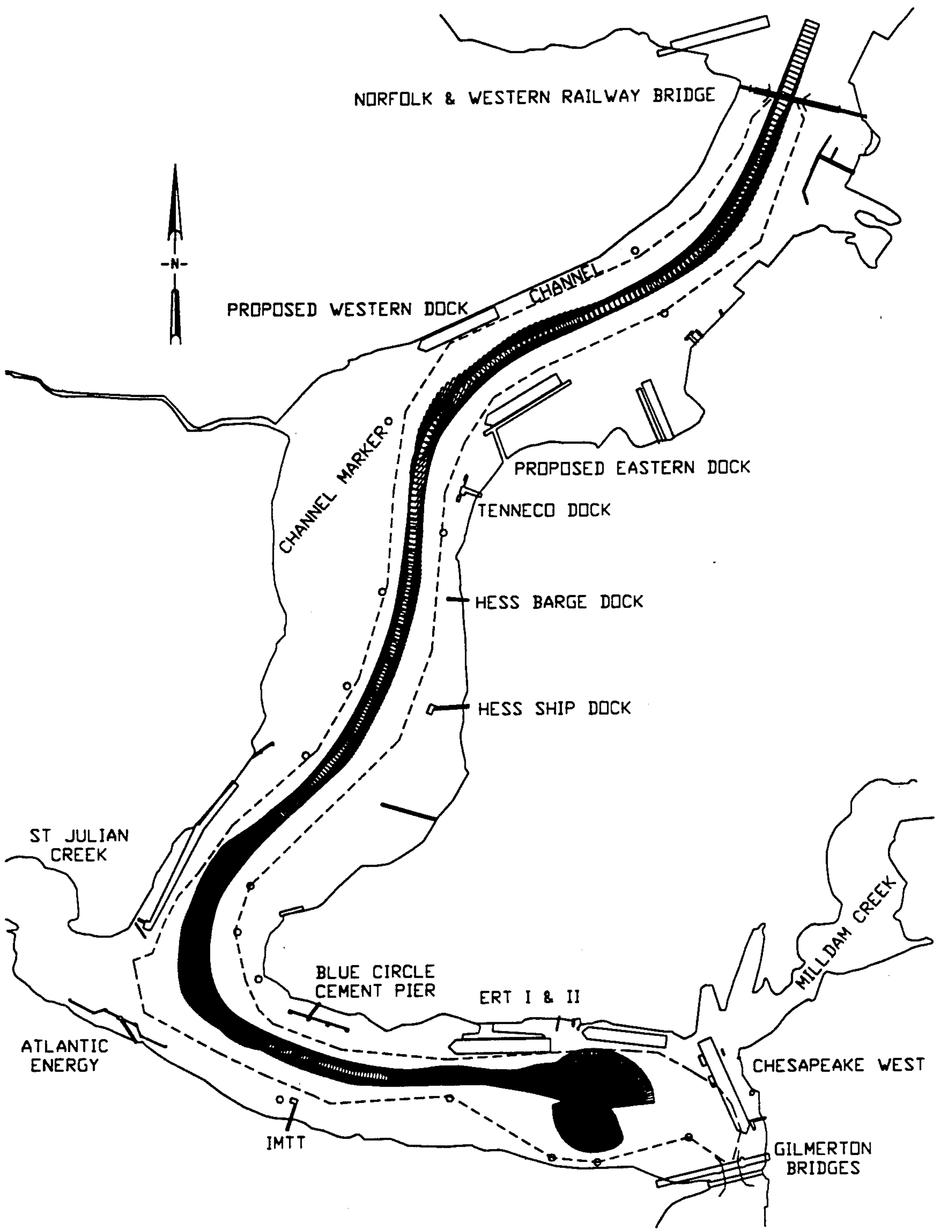


VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 2, RUN 2


NORFOLK & WESTERN RAILWAY BRIDGE
CHANNEL
PROPOSED WESTERN DOCK
-N-
CHANNEL MARKER
PROPOSED EASTERN DOCK
TENNECO DOCK
HESS BARGE DOCK
HESS SHIP DOCK
ST JULIAN CREEK
MILLDAM CREEK
BLUE CIRCLE CEMENT PIER
ERT I & II
ATLANTIC ENERGY
CHESAPEAKE WEST
IMTT
GILMERTON BRIDGES
VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 3, RUN 1
SCALE IN FEET
0 500 1000

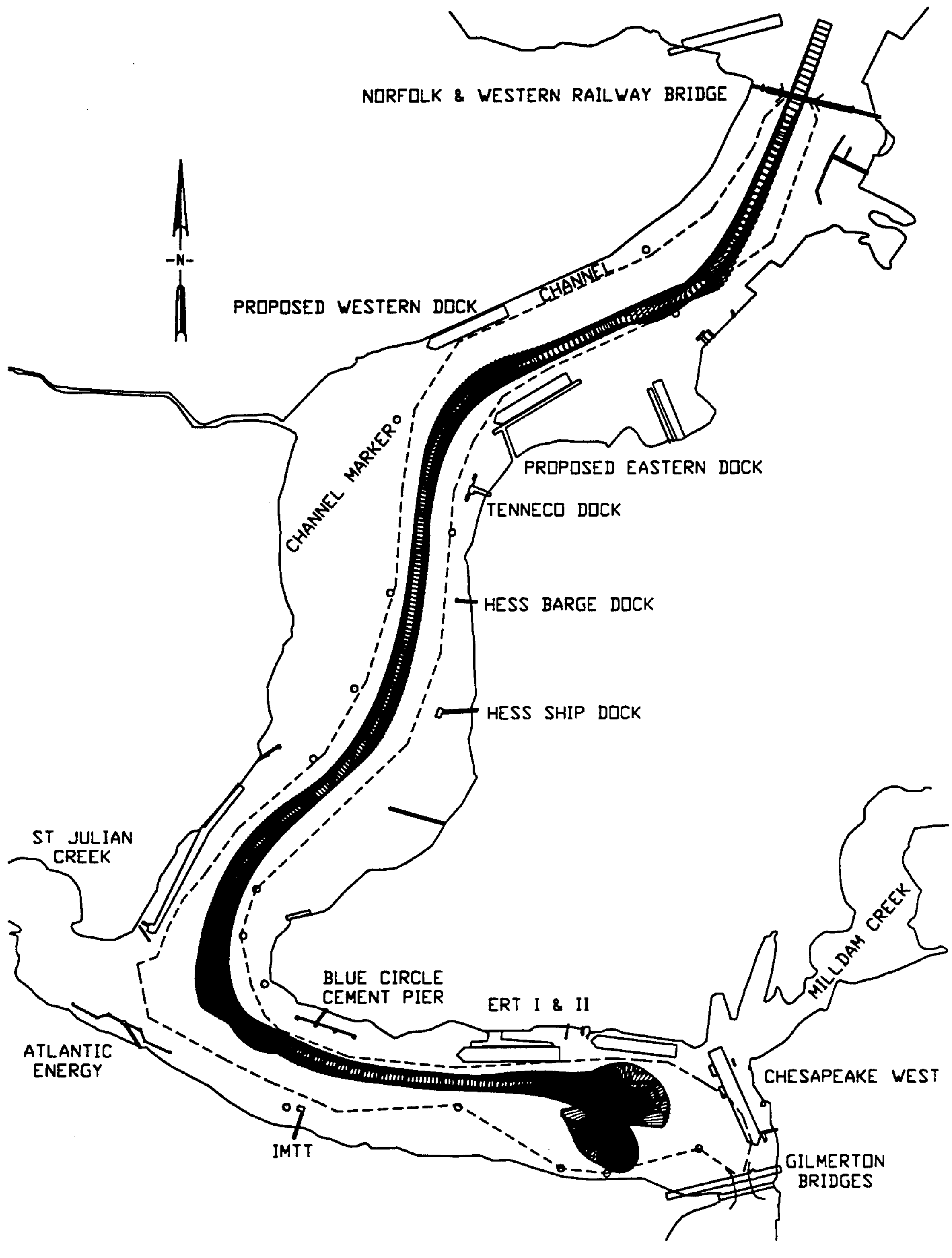


VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 4, RUN 1

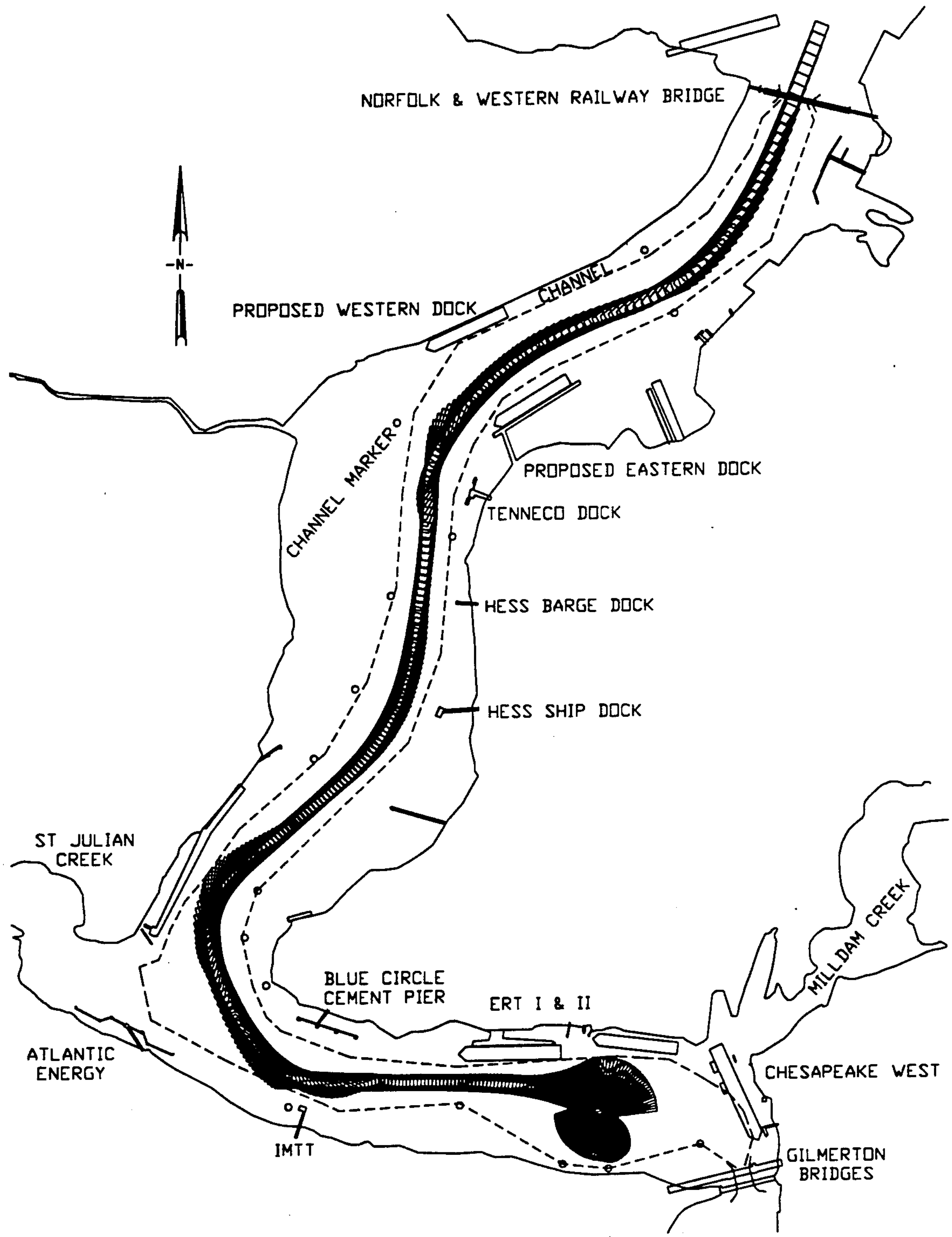


VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 5, RUN 1

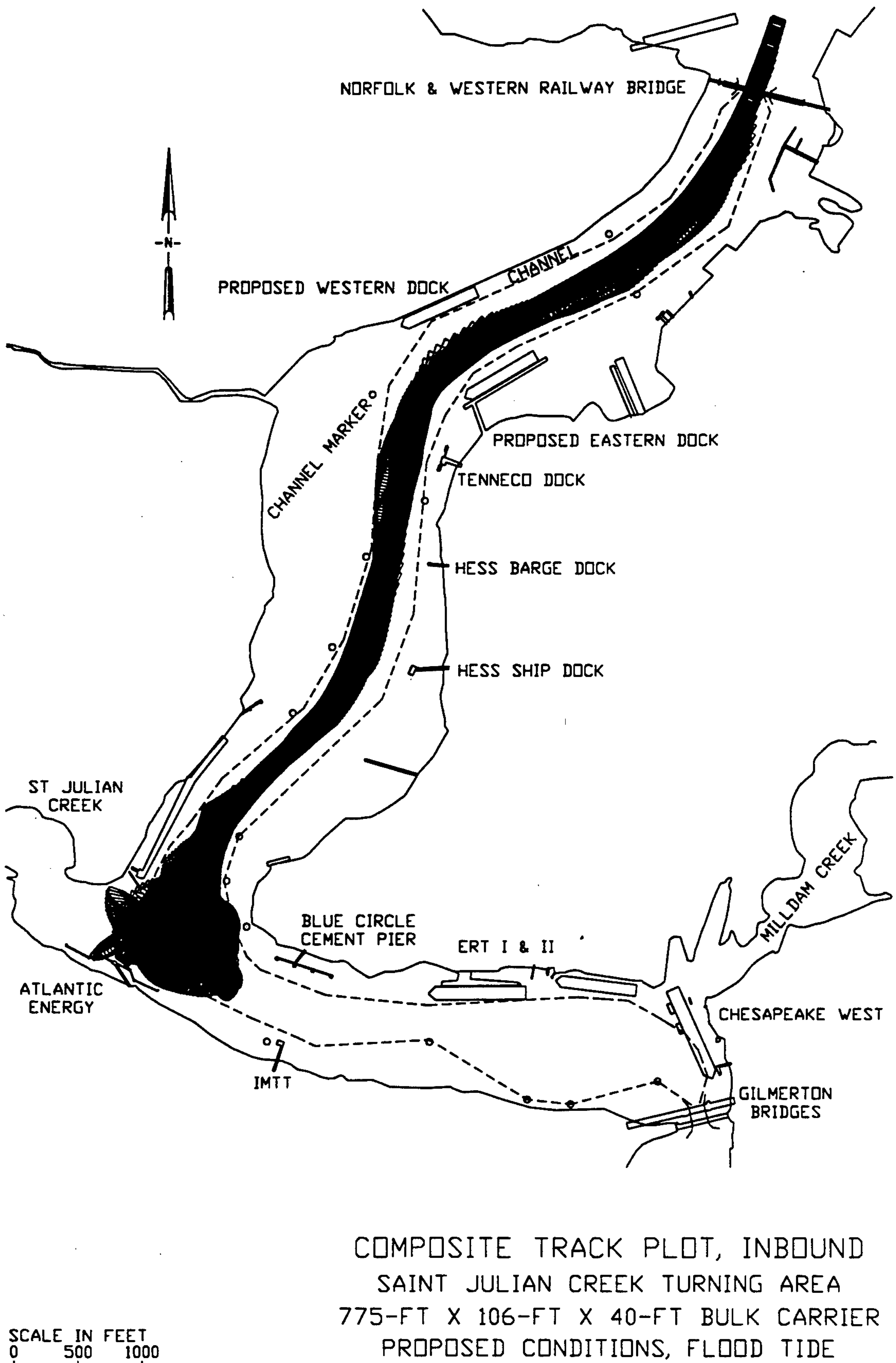
Plate 196



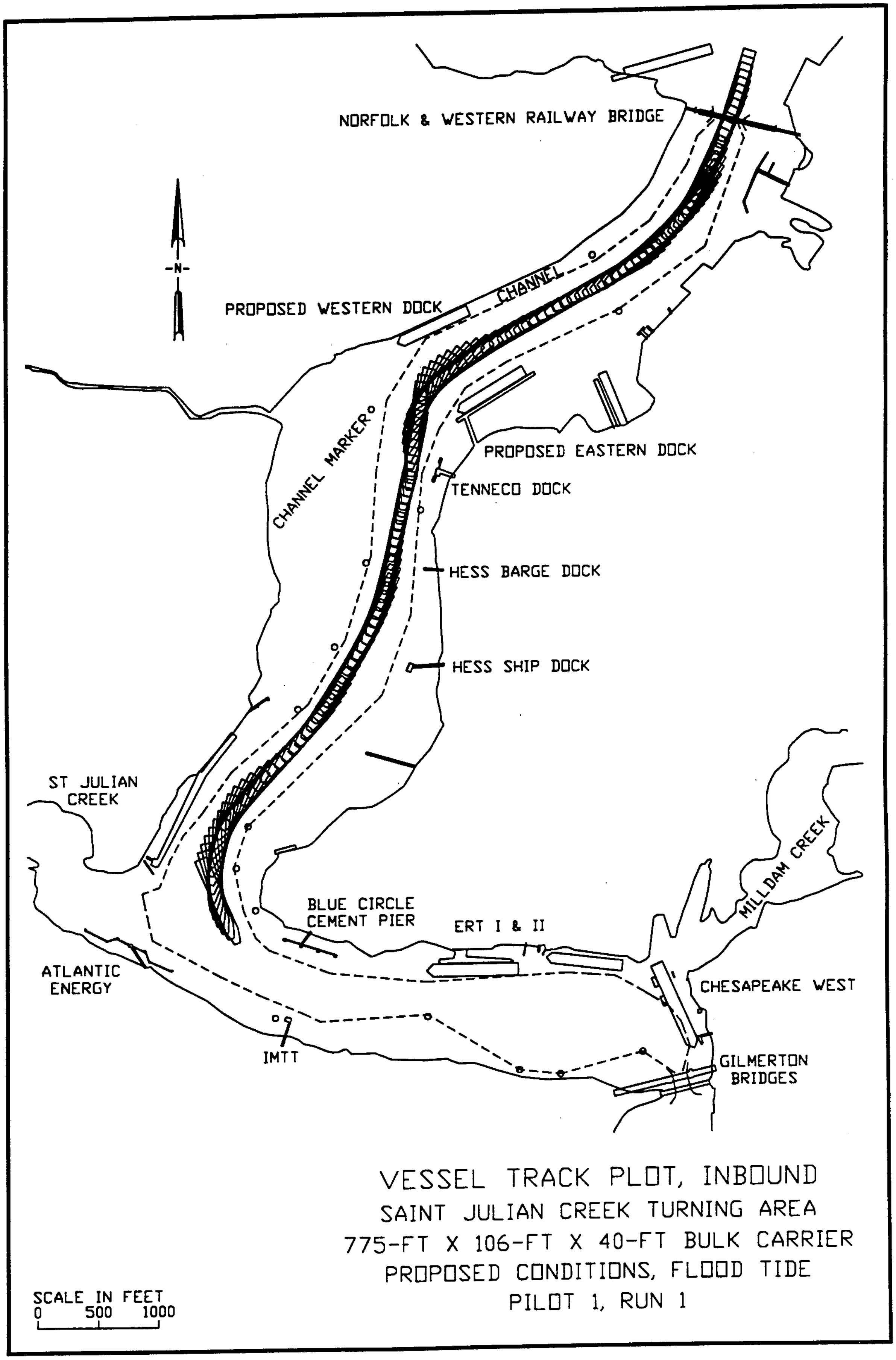
VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6, RUN 1



VESSEL TRACK PLOT, INBOUND
MILLDAM CREEK TURNING BASIN
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6, RUN 2

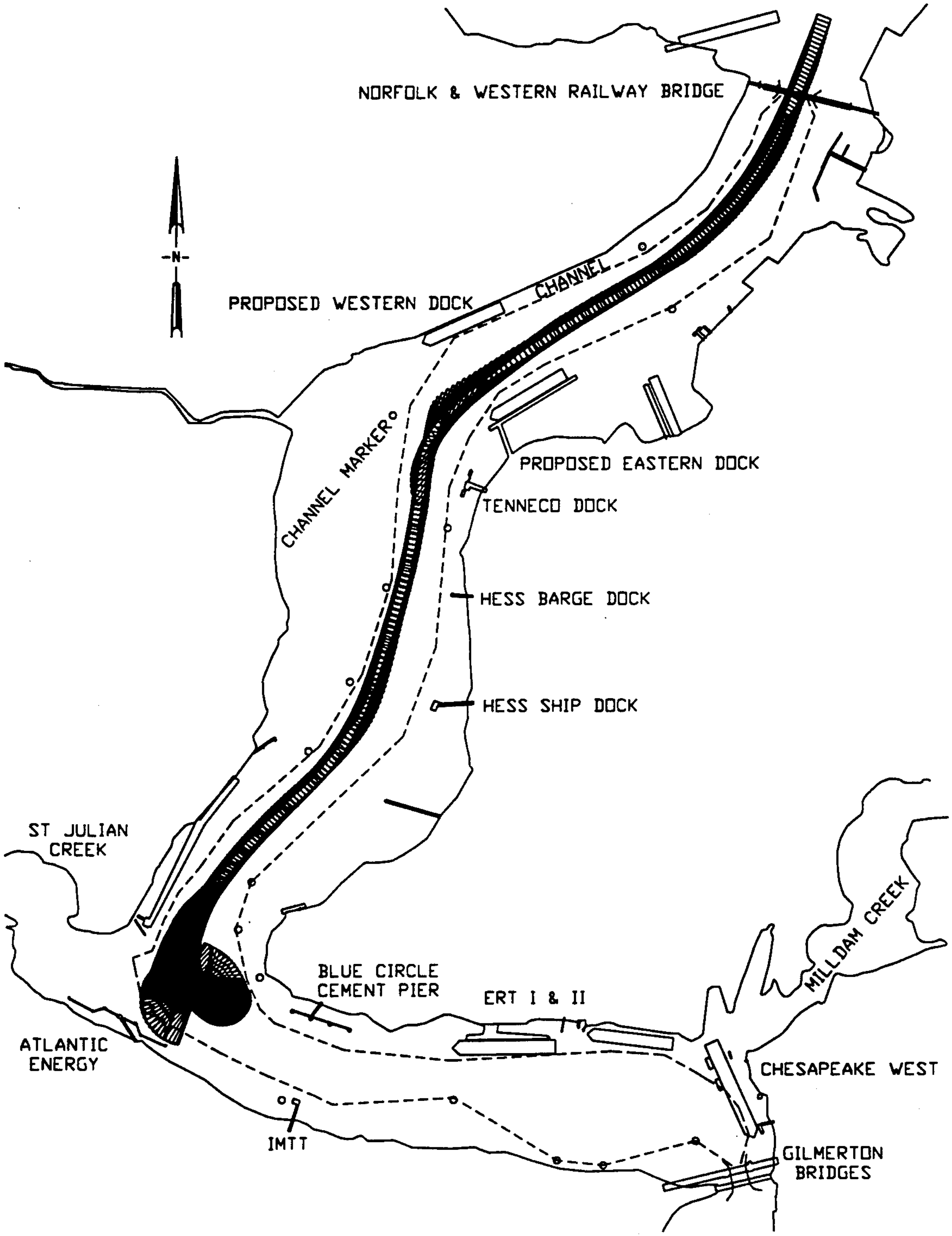


COMPOSITE TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE

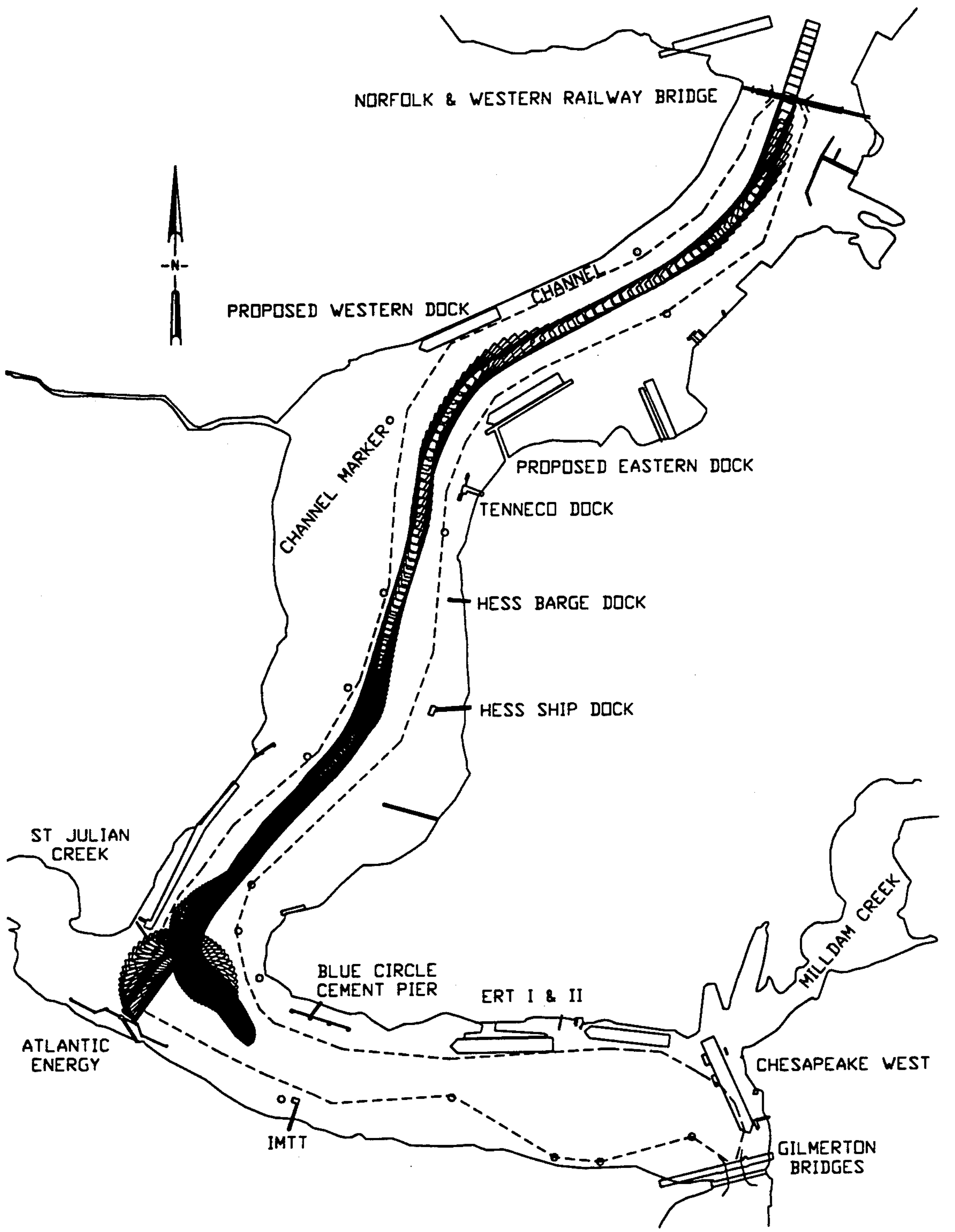


NORFOLK & WESTERN RAILWAY BRIDGE
-N-
CHANNEL
PROPOSED WESTERN DOCK
CHANNEL MARKER
PROPOSED EASTERN DOCK
TENNECO DOCK
HESS BARGE DOCK
HESS SHIP DOCK
ST JULIAN CREEK
MILLDAM CREEK
BLUE CIRCLE CEMENT PIER
ERT I & II
ATLANTIC ENERGY
CHESAPEAKE WEST
IMTT
GILMERTON BRIDGES
VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 1, RUN 1
SCALE IN FEET
0 500 1000

Plate 200

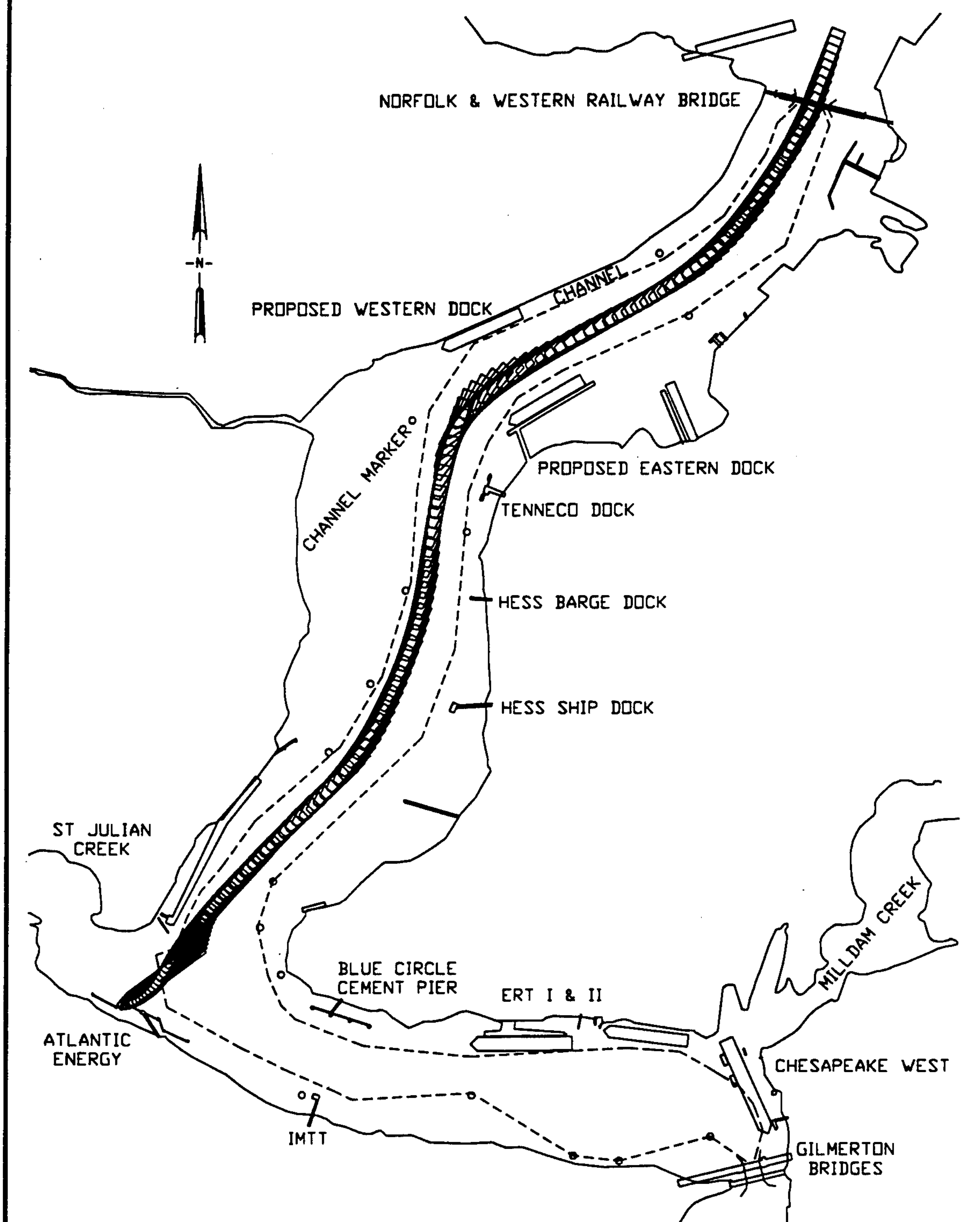


VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 1, RUN 2

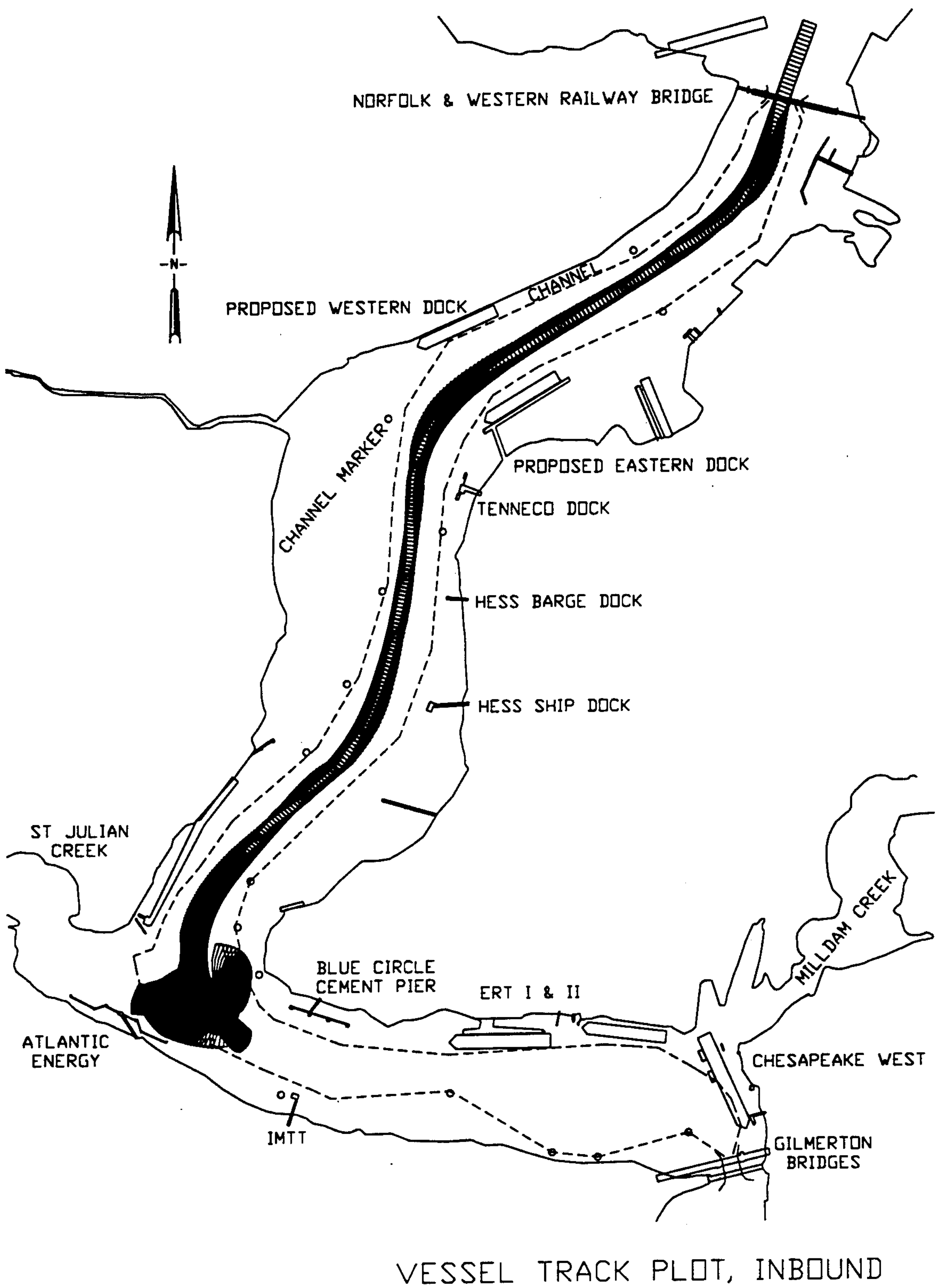


VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 2, RUN 1

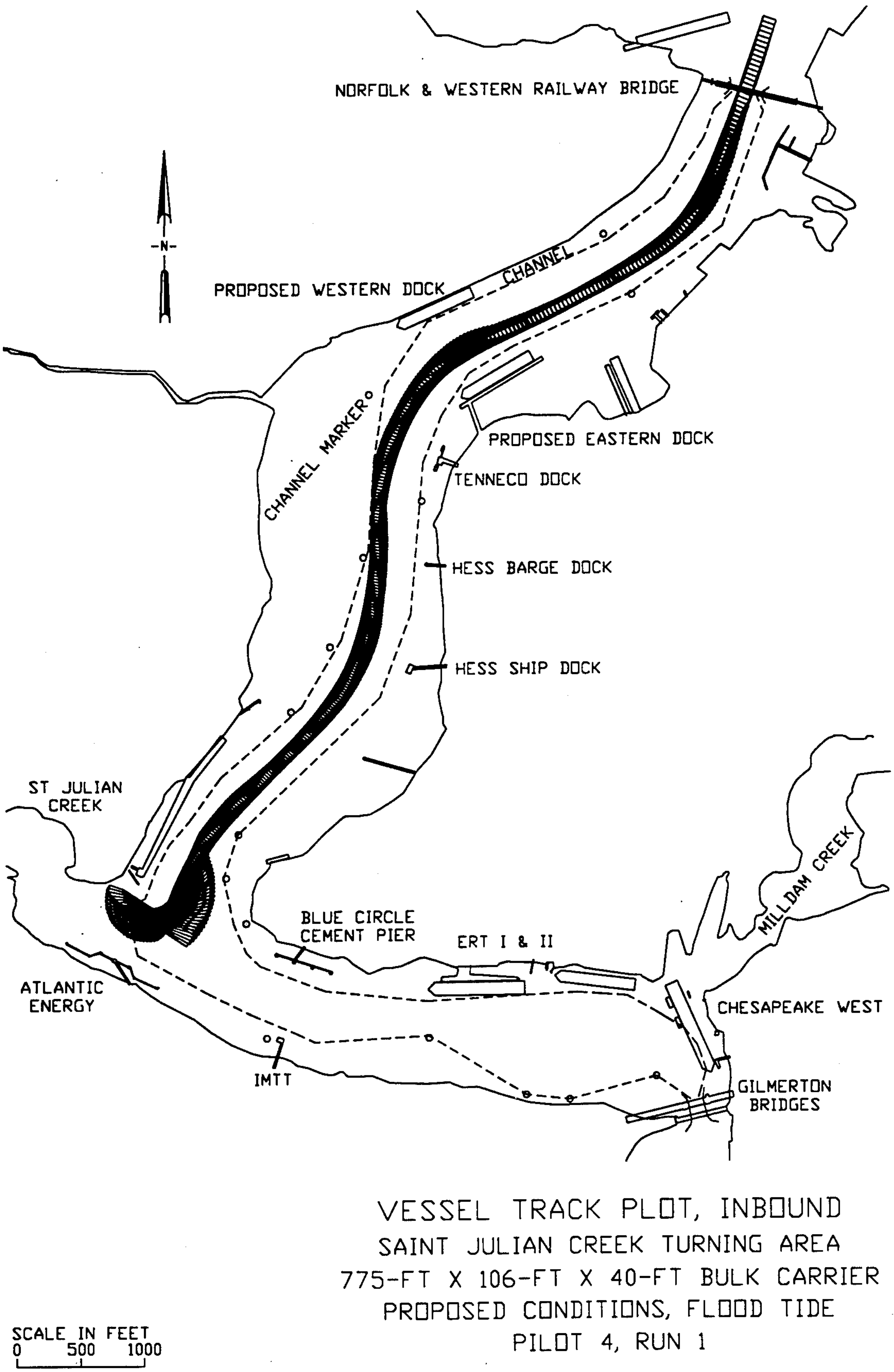
Plate 202



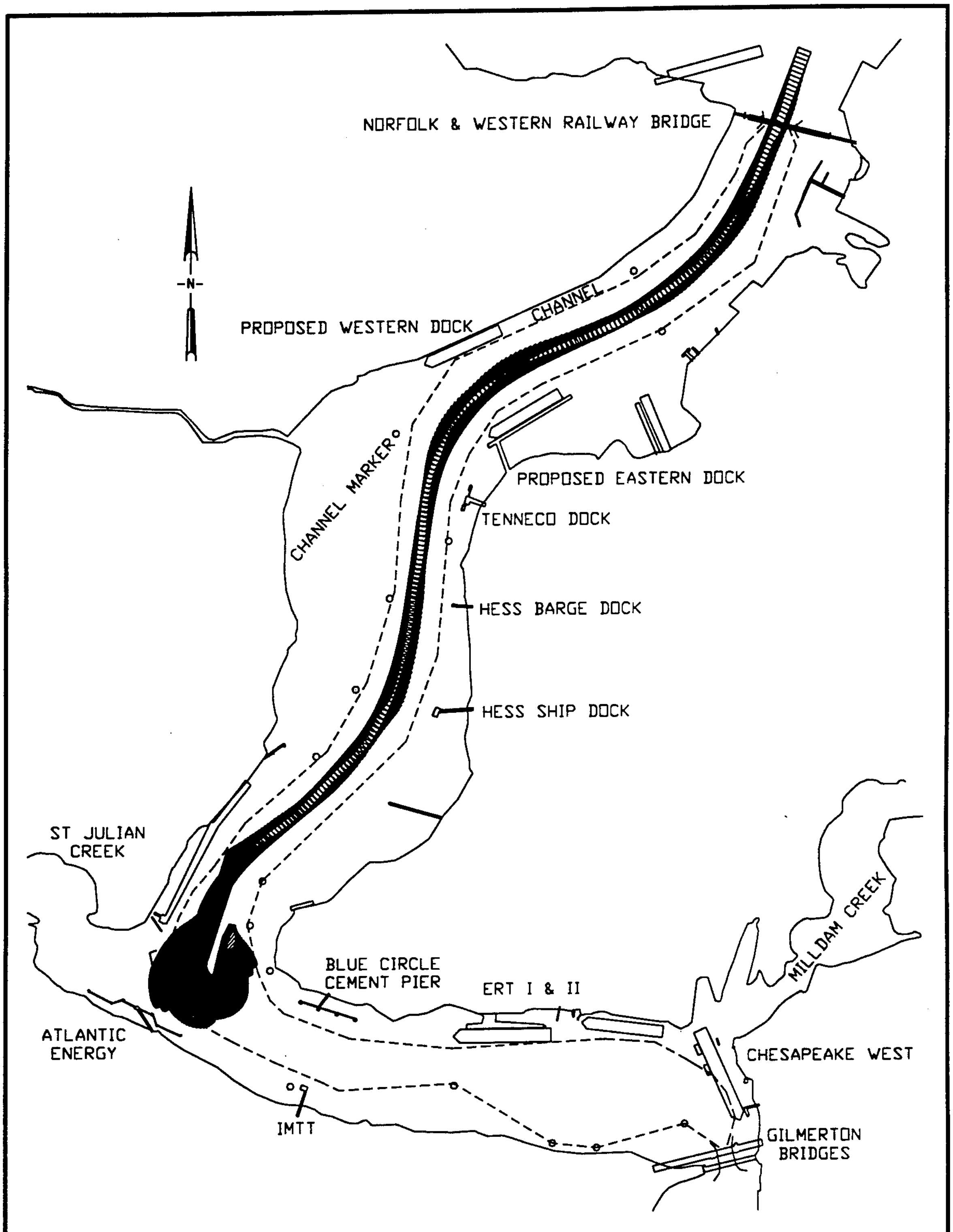
VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 2, RUN 2



VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 3, RUN 1

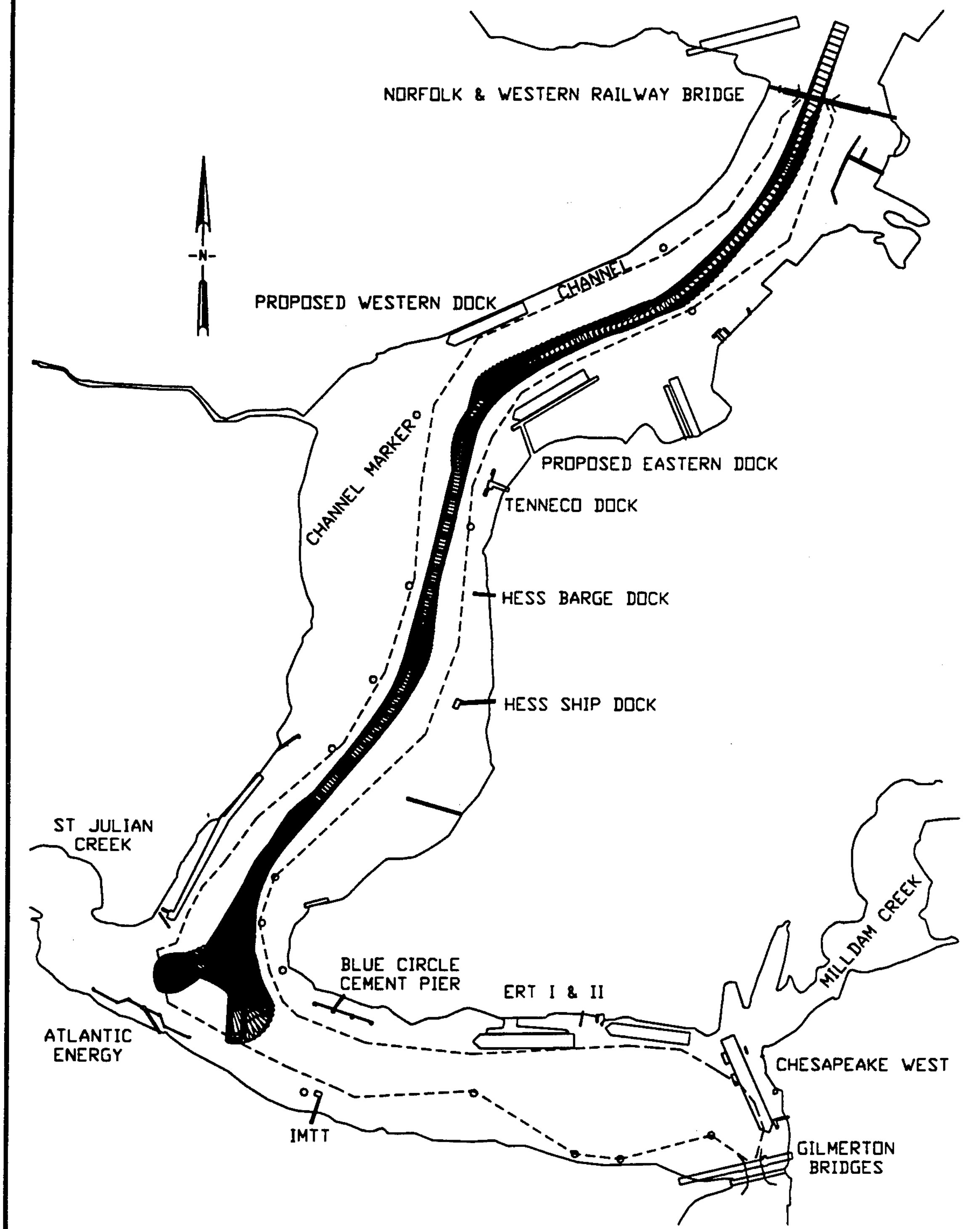


VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 4, RUN 1

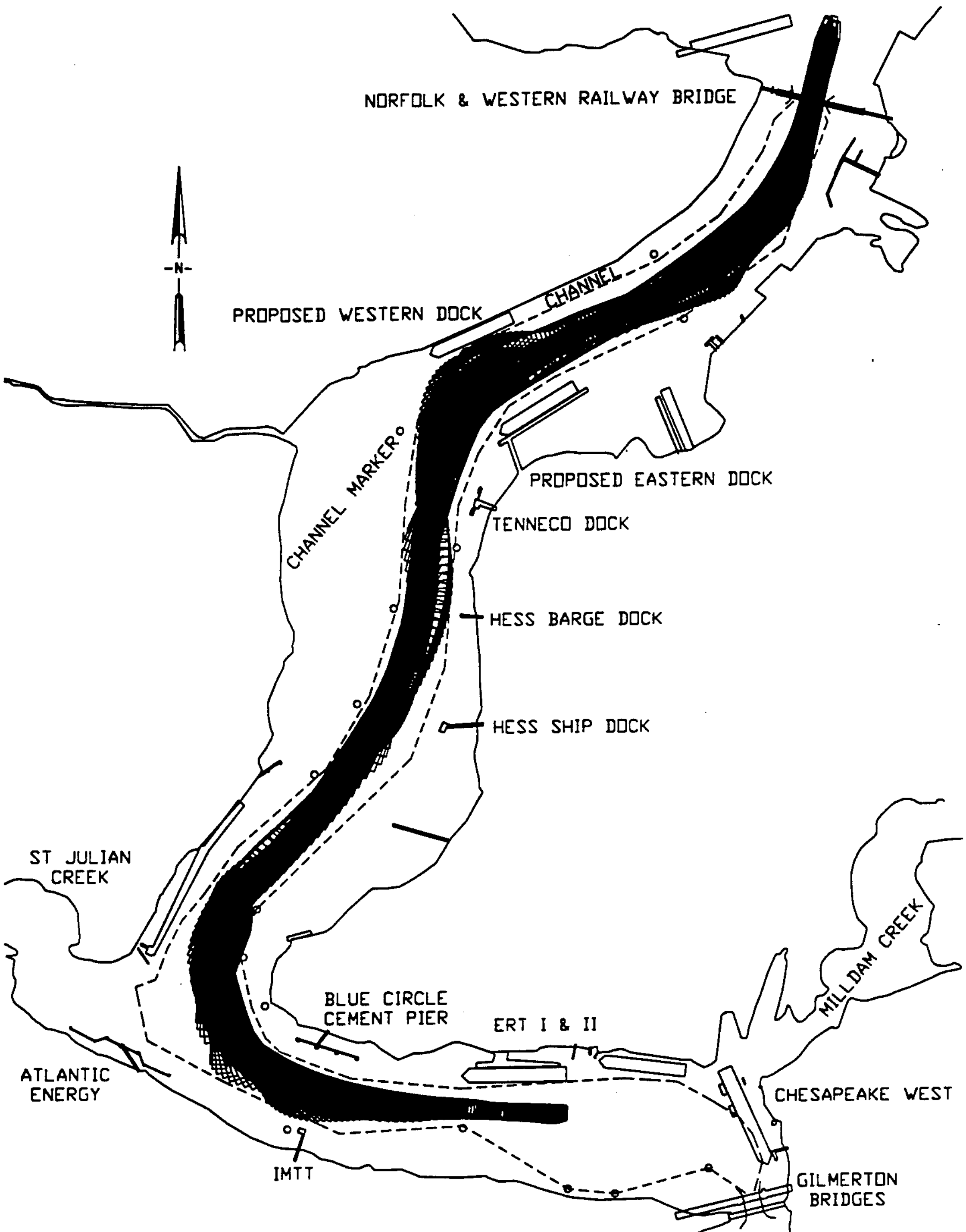


VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 5, RUN 1

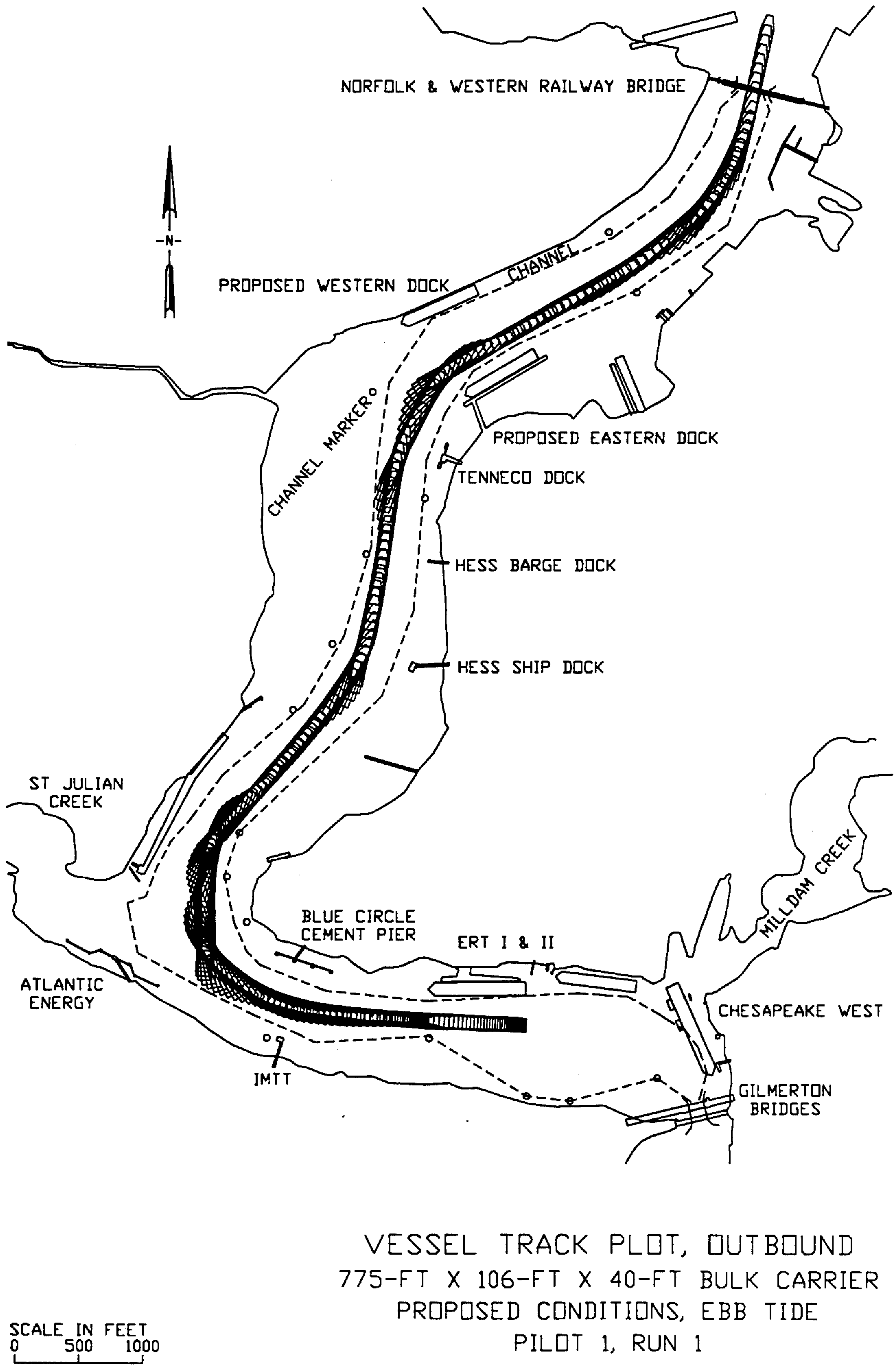
Plate 206



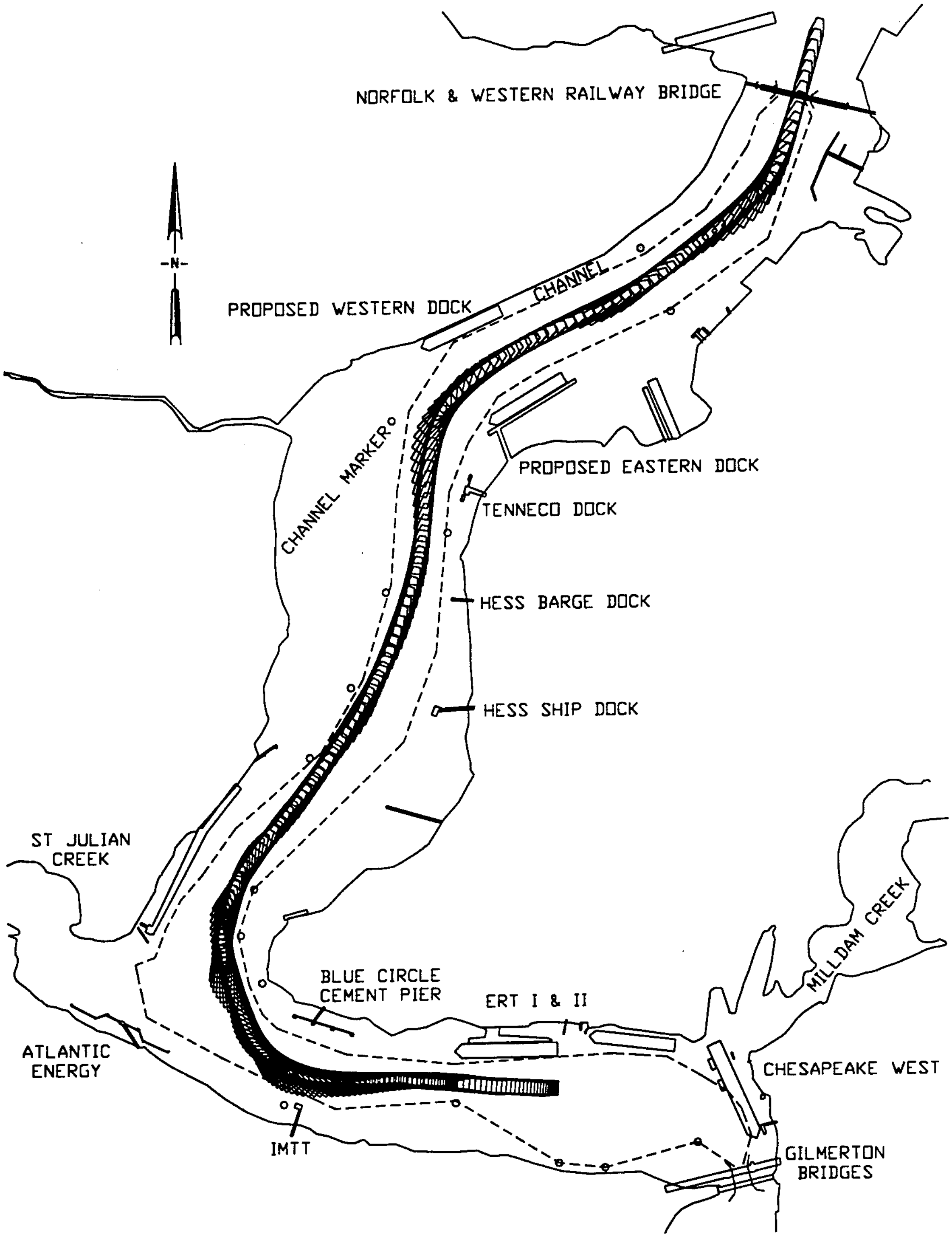
VESSEL TRACK PLOT, INBOUND
SAINT JULIAN CREEK TURNING AREA
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, FLOOD TIDE
PILOT 6, RUN 1



COMPOSITE TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE

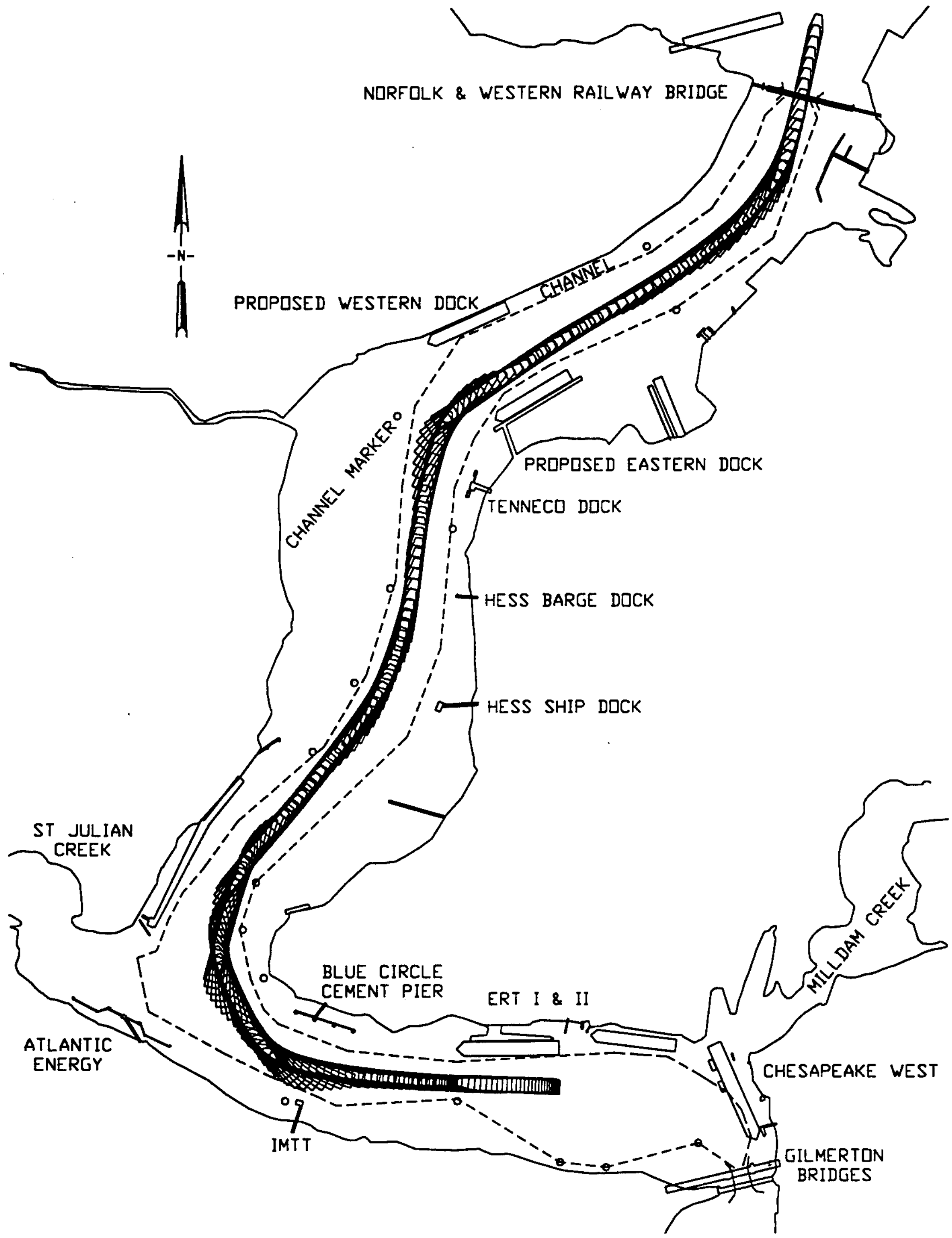


VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 1, RUN 1

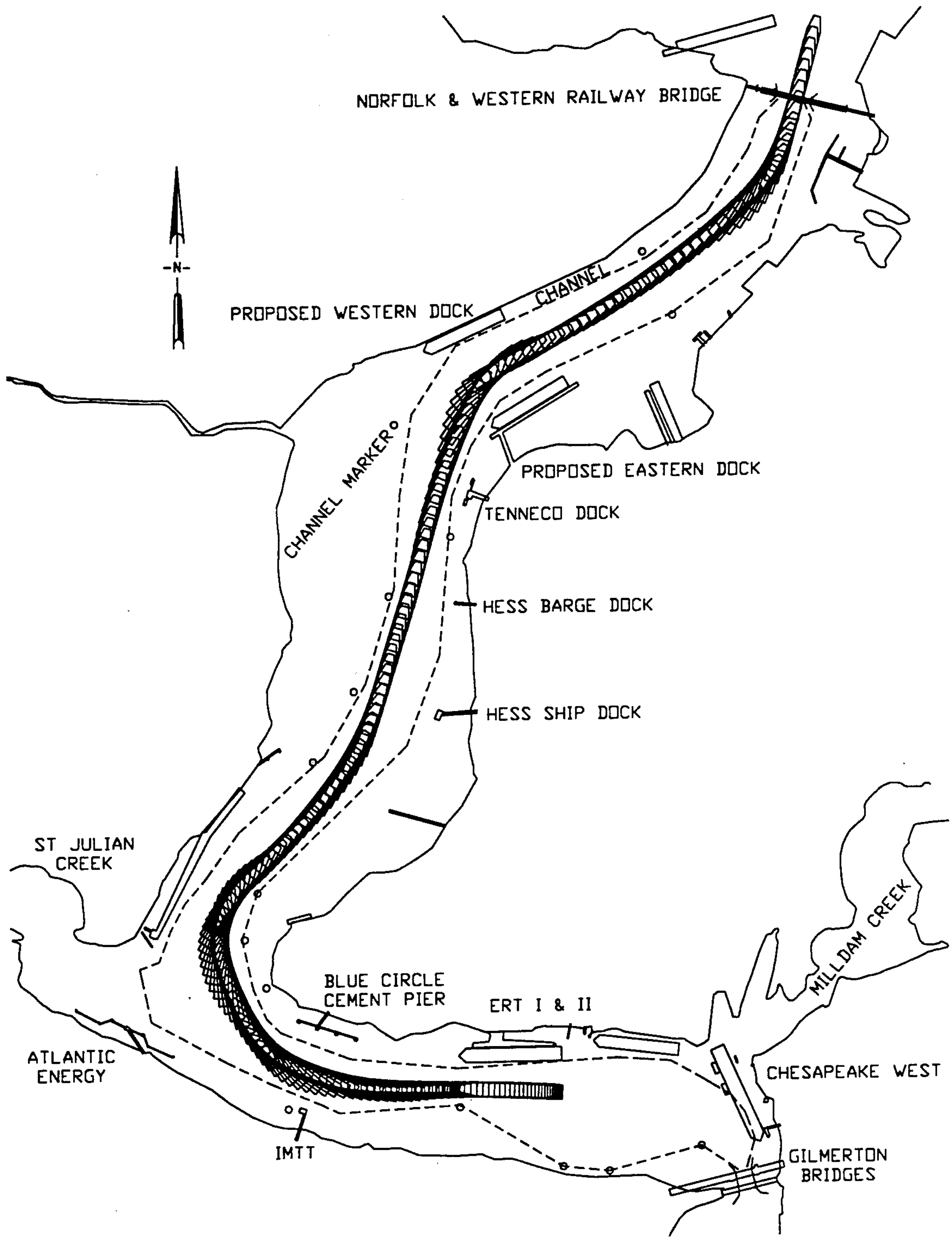


VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 1, RUN 2

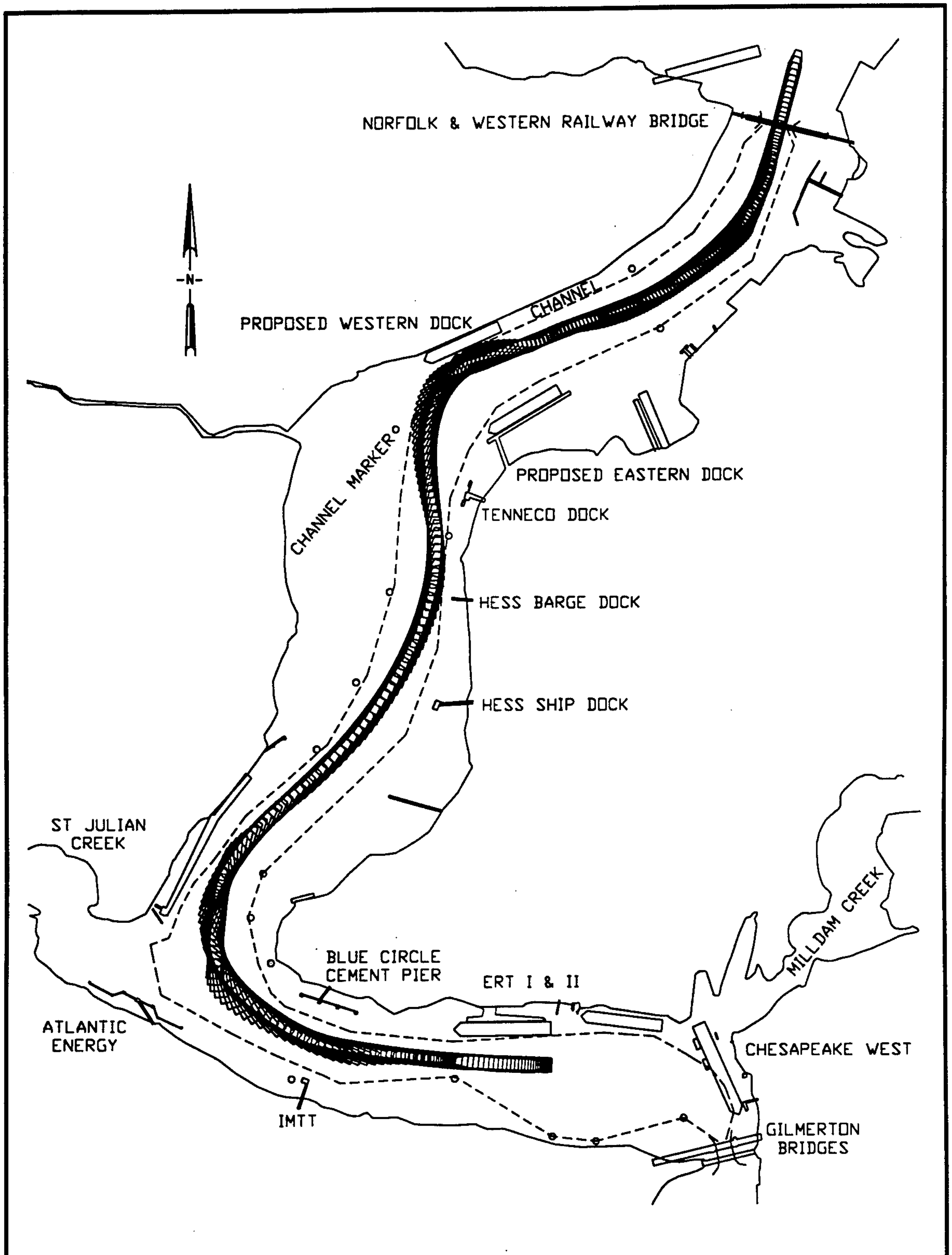
Plate 210



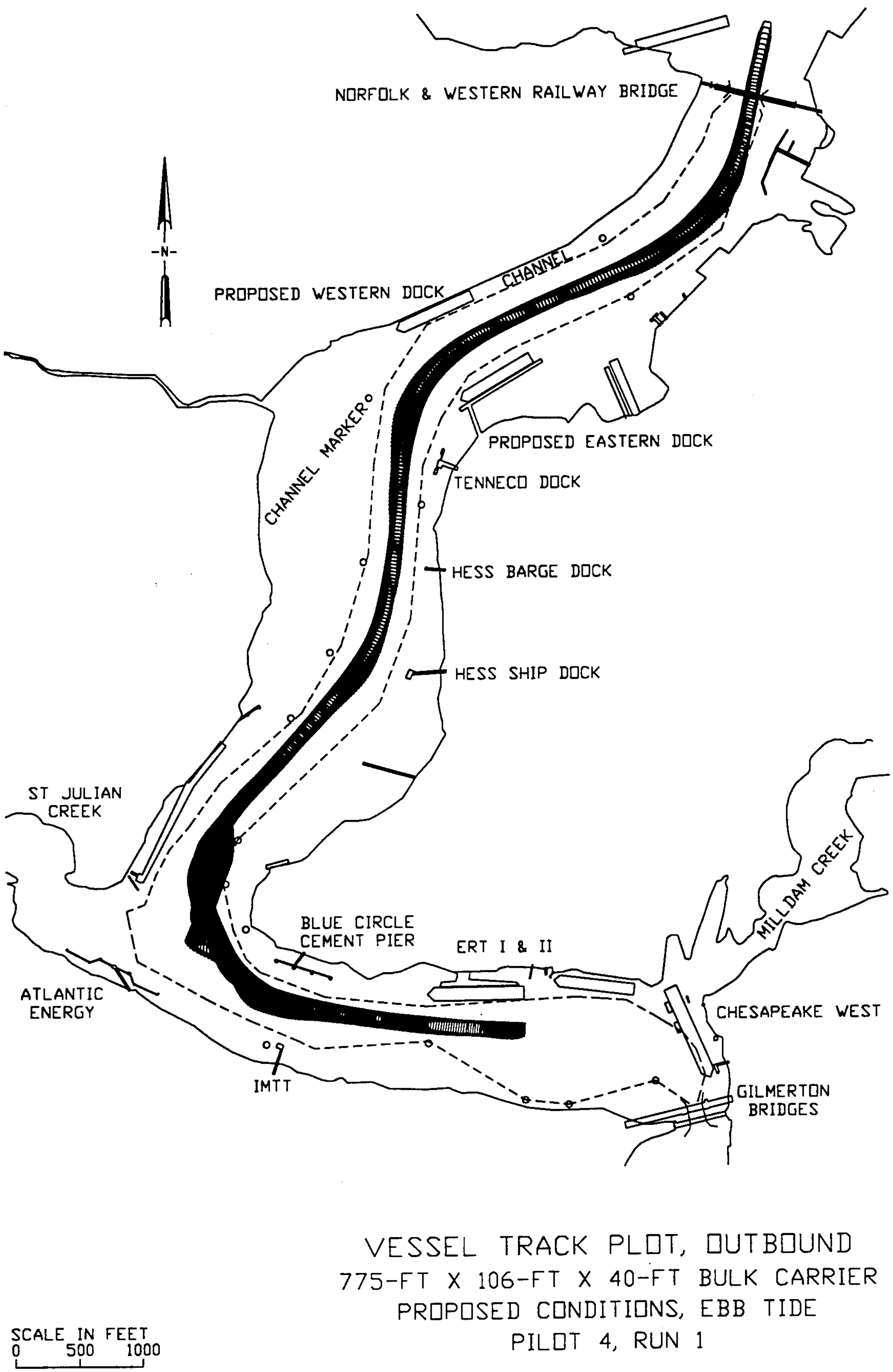
VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 2, RUN 1



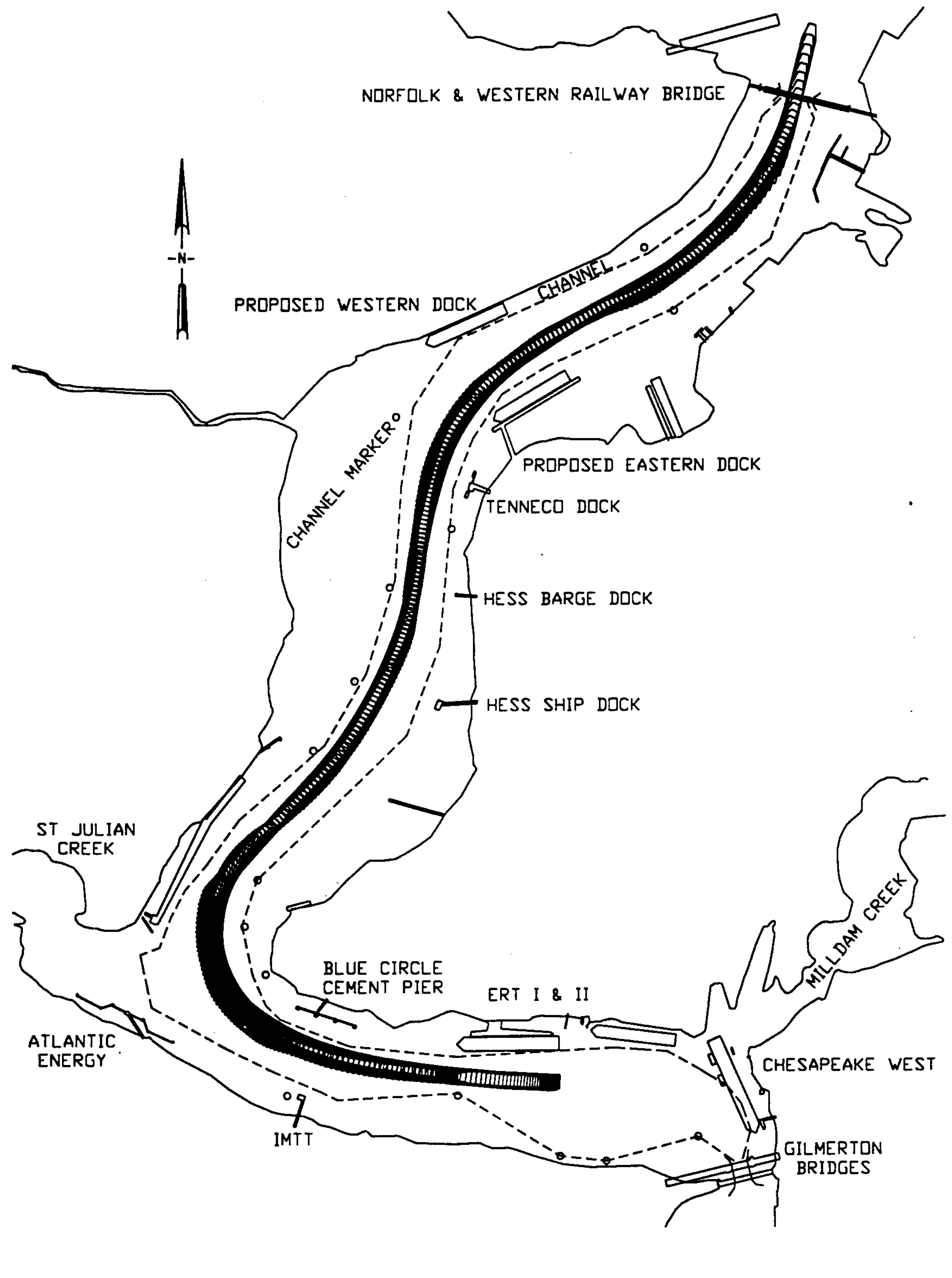
VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 2, RUN 2



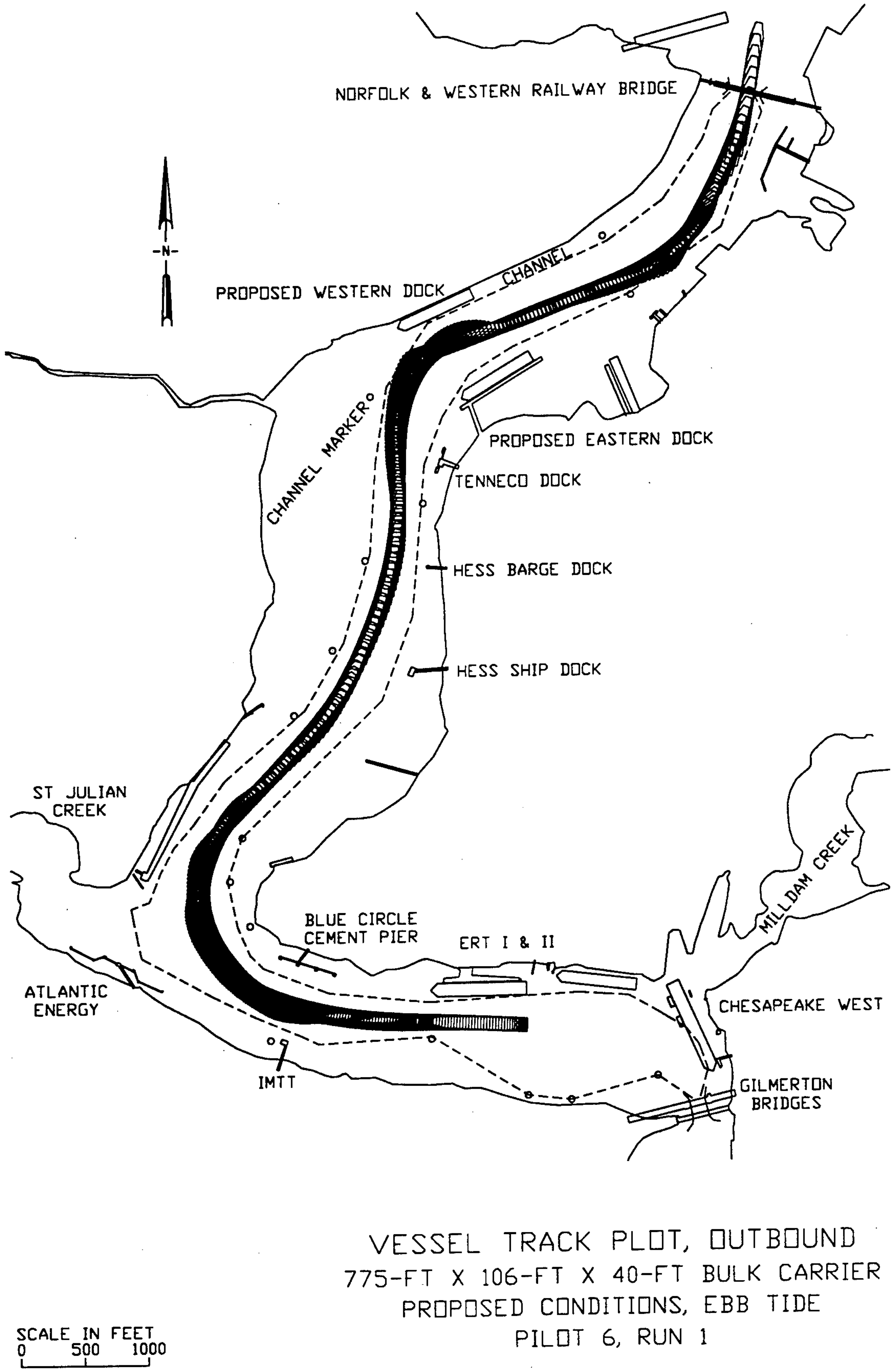
VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 3, RUN 1



VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 4, RUN 1



VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 5, RUN 1



VESSEL TRACK PLOT, OUTBOUND
775-FT X 106-FT X 40-FT BULK CARRIER
PROPOSED CONDITIONS, EBB TIDE
PILOT 6, RUN 1

Plate 216

Appendix A
Flow Model Testing

The Numerical Model

The Elizabeth River and Southern Branch Navigation Study was conducted with the Corps' numerical modeling system, "Open-Channel Flow and Sedimentation, TABS-2," to evaluate the impact of channel deepening. Hydrodynamic model predictions of currents were used in the ship simulator evaluation of proposed channel improvements. The numerical model used was RMA2, a two-dimensional model for free surface flows. RMA2 uses a finite element solution of the Reynolds form of the Navier-Stokes equations for turbulent flow. The model has been successfully applied in numerous U.S. Army Corps of Engineers applications to inland and coastal waters.

Elizabeth River Numerical Mesh

To apply the RMA2 code to the system, a numerical mesh composed of 1,886 elements and 6,163 nodes was developed. The mesh for the existing conditions begins at Portsmouth and ends at Rock Creek. It includes all the features shown on the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) Nautical Chart No. 12253. The mesh in Figure A1 was designed to ensure properly sized elements and reasonable depth change across elements. A high level of resolution was required to represent the circulation patterns in sufficient detail to allow for accurate representation of currents for the ship simulator study (Figure A2). All depths used were referenced to mean low water (mlw), and the mesh was overlayed with a CAD drawing of the shoreline and channel to maintain the proper alignment of the numerical model. The base mesh contained 1,886 elements and 6,163 nodes.

Model Validation

After the mesh was developed, a predicted tide from the Tide Tables

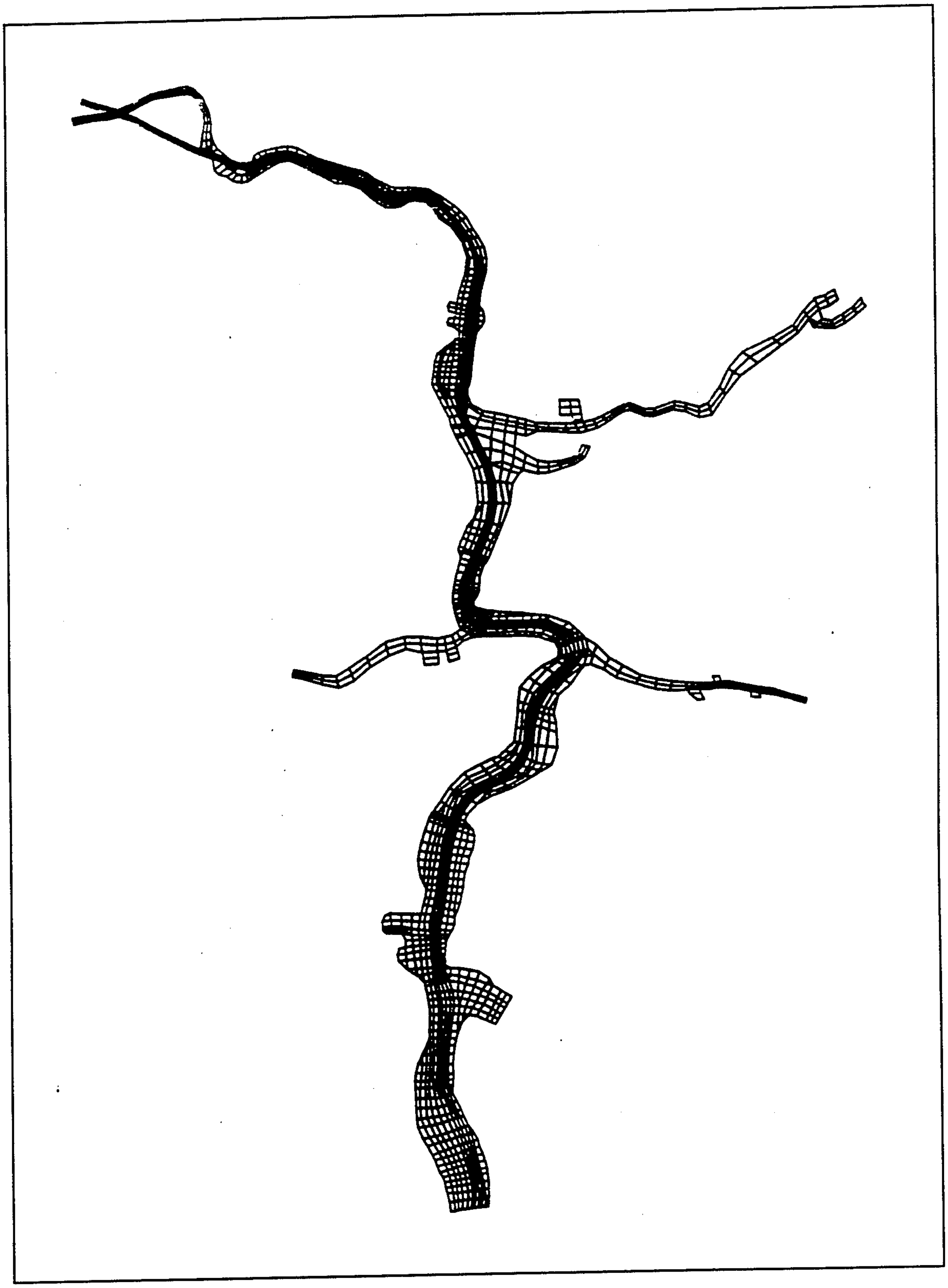


Figure A1. Mesh for existing conditions

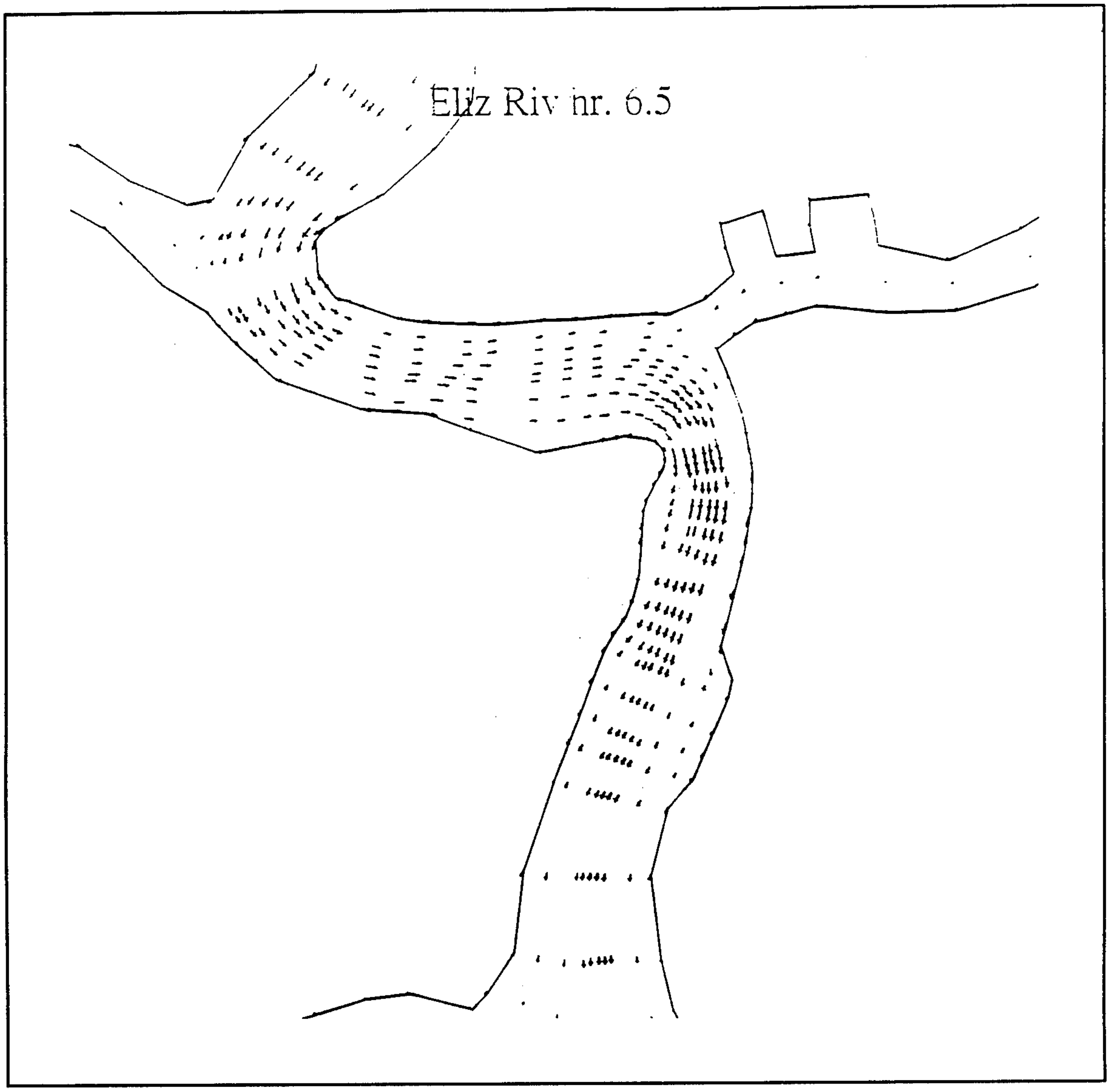


Figure A2. Currents used for the ship simulator study

(U.S. Coast and Geodetic Survey)[1] was used to drive the model. Predicted tide range at Portsmith was 4.2 ft mlw. Several test runs were made with the available data until the model produced reasonable results.

On 29 January 1994, a survey of the Elizabeth River, Southern Branch, area was conducted by the U.S. Army Engineer Waterways Experiment Station (WES). Data recording instruments were positioned at six locations within the study area (Figure A3). Tide stations were located at Portsmith and near Milldam Creek. Velocity stations were located in the channel near St. Julian Creek, Gilmerton Bridge, and Newton Creek. These data were processed and later used to make other adjustments to the numerical model. The model was

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1 References cited in this Appendix are included in the References at the end of the main text.

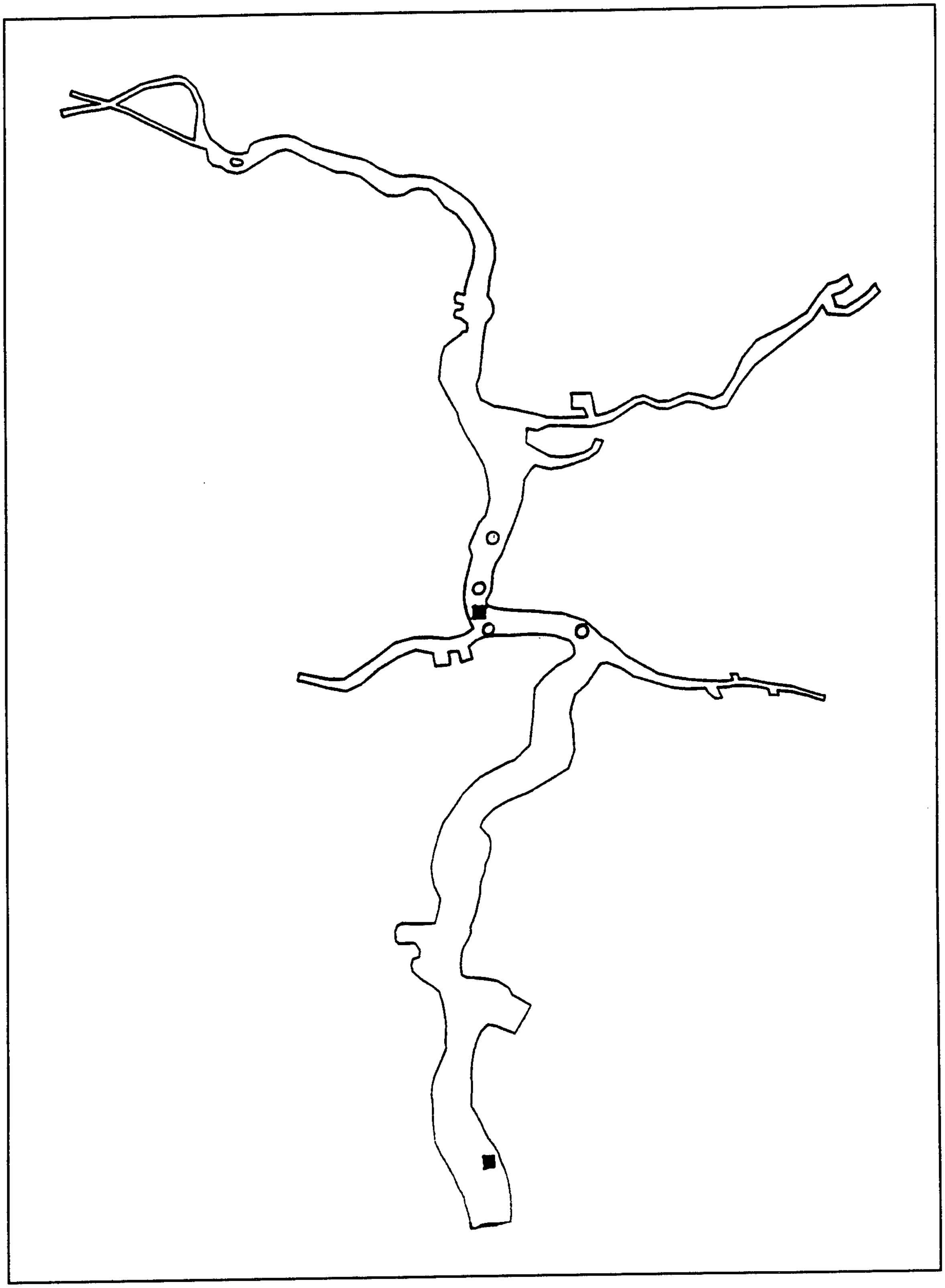

Figure A3. Field data recording instrument locations adjusted until reasonable results were produced at the selected tide and velocity locations (Figures A4 and A5). Boundary conditions established after validation were the final conditions used for all tests (Base, Plan 1, Plan 2, and Plan 3).

Procedure and Results

Three plan conditions were modeled with the numerical model. Velocities and water-surface elevations were compared at several locations of interest within the Elizabeth River channel. The results of all plan runs produced no change in phase or water-surface elevations. Velocities around the Gilmerton area changed very little between base and plan runs.

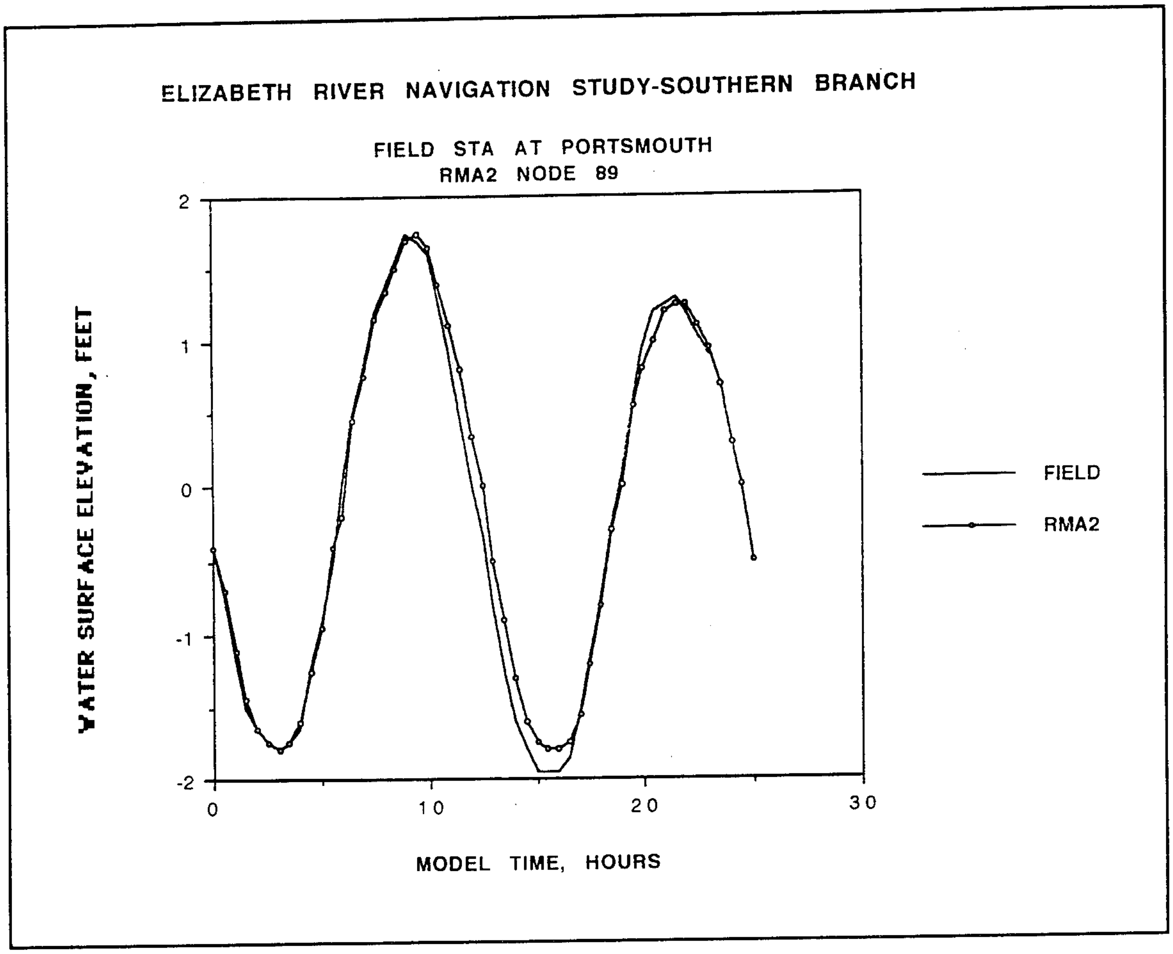

Figure A4. Tidal verification

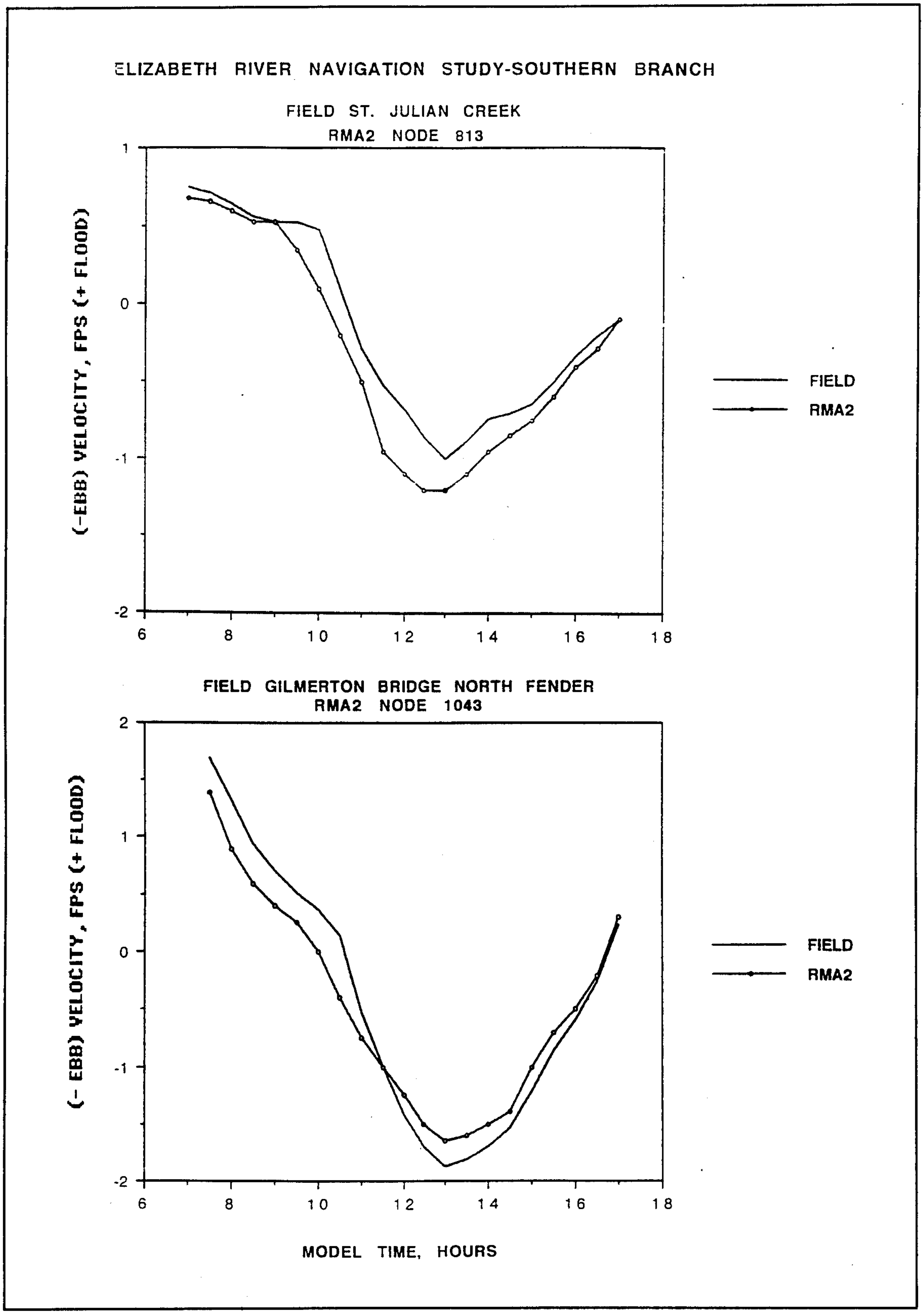

Figure A5. Velocity verification

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13. ABSTRACT *(Maximum 200 words)*

The Southern Branch of the Elizabeth River is located in Norfolk, Portsmouth, and Chesapeake, VA. The existing 125-ft-span Gilmerton Bridges are positioned in the Southern Branch just south of an approximately 90-degree bend in the river. Therefore, inbound (southbound) vessels have very little room to line up with the bridges' fender system. Outbound ships have to turn to port immediately after passing through the bridge span or risk hitting a ship docked at a facility immediately north of the bridges. Vessels are often docked on the eastern side of the river, upstream and downstream of the bridges. This further reduces the area available for the the mariner to maneuver his vessel.

The I-64 Bridge crosses a straight reach of the channel, but the bridge supports are not aligned with the channel and the bridge itself is at an angle of 59 degrees, not perpendicular, to the channel alignment. In addition, the navigation opening is not in the center of the river; therefore, tug captains experience difficulties lining up their vessel with the center of the bridge span. There are no ranges marking the center line of the channel in this area.

(Continued)

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13. ABSTRACT (Concluded).

Vessels passing through the bridges include ships and oceangoing, integrated tug/barge units. At the present, ship traffic terminates at Newton Creek Turning Basin. The integrated tug/barges travel south of the I-64 Bridge to call at the Huntsman Chemical Dock. Both ships and barges are loaded for the inbound transit. Outbound barges are empty and outbound ships are light-loaded or in ballast. The outbound condition is regarded as the most difficult to navigate because the increased freeboard is subjected to wind. Winds in the area are predominantly from the northeast and northwest. The outbound runs pose an additional problem for the integrated tug/barge units because empty barges extend well past the waterline and block the view from the tug's pilothouse.

The navigation study was conducted using the U.S. Army Engineer Waterways Experiment Station Hydraulic Laboratory's ship/tow simulator facility. The objectives of the study were to

a. Evaluate the effects of extending the 40-ft-channel depth improvement to the Newton Creek Turning Basin.

b. Evaluate the 40-ft-channel deepening plan with widening as recommended by the 1989 study, and evaluate the effects of two proposed dock facilities on this channel plan. Each of these facilities will require removal of a channel marker.

c. Evaluate modifications of the Milldam Creek Turning Basin, with consideration to reducing impacts on wetlands and real estate requirements.

d. Evaluate navigation conditions for both ship and barge traffic through the existing 125-ft-wide Gilmerton Bridges and recommend a bridge span width for future construction.

e. Evaluate navigation conditions for barge traffic only through the existing 125-ft-wide I-64 Bridge and recommend a bridge span width for future construction.